SPATIAL AND TEMPORAL DISTRIBUTION OF BENTHIC MACROINVERTEBRATES AND SEDIMENTS COLLECTED IN THE VICINITY OF THE J. H. CAMPBELL PLANT, EASTERN LAKE MICHIGAN, 1980

MICHAEL H. WINNELL

and

DAVID J. JUDE

Special Report Number 87

Great Lakes Research Division

The University of Michigan

Ann Arbor, Michigan

November 1981

ACKNOWLEDGMENTS

This study was funded by a grant from Consumers Power Company, Jackson, Michigan, through their Environmental Services Department. We are indebted to Ibrahim Zeitoun and John Gulvas for their congenial treatment and help through all phases of this project. Nelson Navarre from the Great Lakes and Marine Waters Center was also very helpful with the administrative aspects of the study. We would like to express our gratitude to Great Lakes Research Division benthos personnel whose invaluable assistance helped produce this report. Special thanks are due to Polly Fairchild and Catherine Pringle who sorted and identified the majority of the animals collected. We would like to express our appreciation to Thomas Zdeba who identified the pisidia, David White for confirmation of trichopteran identifications, and Jarl Hiltunen and Roger LaDronka who aided with distinguishing the naidids. In addition, Polly Fairchild, Catherine Pringle, Roger LaDronka, Catherine Zawacki, David White, Thomas Zdeba, Lynn Schwenk, Janis Skadsen, and Zeny Catalan aided in collection of animals and sediments during field surveys; they are thanked for their assistance. We are grateful to the crew of the R/V Mysis (Captain Clifford Tetzloff and Glenn Tompkins) and to George Heufelder and Clifford Tetzloff for scheduling, logistics, and patience.

Appreciation for sediment analysis is extended to Ronald Rossman. Special thanks are given to William Chang for editing and for his untiring help with statistical problems associated with this project, Catherine Pringle for the tedious job of inking all figures, Linda Gardner for careful typing of all tables, and Steve Schneider for

assistance in the production of this report. We thank Frank Tesar for his thorough review and many helpful comments regarding this report. Sherry Stapleton, Judy Farris, Jan Farris, and Linda Gardner are thanked for handling requisitions, time cards, and travel requests.

TABLE OF CONTENTS

INTRODUCTION

The J.H. Campbell Plant is comprised of three coal-fired operational units. While Units 1 and 2 have used and will continue to use Lake Michigan water drawn through Pigeon Lake for cooling purposes, Unit 3 draws cooling water from an intake structure located in approximately 11 m of water (1.1 km offshore) in Lake Michigan. Beginning in September 1980, heated water from all three units was discharged through the offshore discharge structure located in approximately 6 m of water (0.3 km offshore). In the initial design of the benthos survey, 1980 was expected to be an operational year. However, due to the late date in 1980 when discharging of warm water offshore began, 1980 was considered a preoperational year. As such, 1980 will be evaluated along with the previous 2 preoperational years, 1978 and 1979, when comparable data were collected.

Concurrent with reports on larval, juvenile, and adult fish (Jude et al. 1978, 1979, 1980, and 1981), this is the fourth in a series of five reports on the benthos that began in 1977. A summary of the intent of each report is given in the third of the series (Winnell and Jude 1980), but for greater detail for 1977 see Jude et al. (1978), for 1978, see Winnell and Jude (1979), and for 1979, see Winnell and Jude (1980). While the overall purpose of the study design is to determine whether regional density and species composition of the benthos collected from preoperational years differ significantly from estimates covering the operational period, the purpose of this report is to examine all preoperational data for natural, inherent ecological trends, whether they

be associated with years, months, depths, or regions. Density, community structure, and species composition trends will be examined.

The general distribution of benthos in southeastern and eastern Lake Michigan has been summarized in previous reports (Winnell and Jude 1979, 1980) and need not be restated (in addition to Winnell and Jude see Powers and Robertson 1965; Robertson and Alley 1966; Hiltunen 1967; Alley 1968; Mozley and Garcia 1972; Mozley and Alley 1973; Mozley 1974, 1975; Alley and Mozley 1975; Mozley and Winnell 1975; Mozley and Howmiller 1977). With each additional year of data, distribution of the benthos has become clearer. Previous investigations near the Campbell Plant have indicated some regional differences (Truchan 1970, Consumers Power Company 1975). During 1978 and 1979, we noted that while depth and temporal factors account for much of the variability in benthic distributions, regional differences do exist and need to be monitored. Analyses of the 1979, plus 1978 and 1979 data combined, further codified our perceptions of depth and temporal variability patterns within each year and enhanced our conclusions and concerns regarding regional differences. Inclusion of 1980 data, which extends the preoperational period to 3 yr, will enable us to better understand annual variability, particularly as it relates to regional differences. While within-year and depth trends over the 3 yr will be compared and assessed regarding their permanency, the most important aspect will be confirmation of regional differences. A third year of data will clarify regional trends noted during the previous 2 yr.

METHODS

BENTHOS AND SEDIMENT SURVEY DESIGN

The survey was composed of 10 stations located along two transects perpendicular to the eastern shoreline of Lake Michigan near the J.H. Campbell Power Plant, Ottawa County, Michigan (Fig. 1). Along each transect, stations were located at 3-, 6-, 9-, 12-, and 15-m depths. The first transect represented the treatment area (inner region) located 0.16 km north of the offshore intake and discharge structures. The second transect represented the reference area (outer region) located 5.0 km north of the offshore intake and discharge structures. The 1980 survey design was the same as that employed during 1979.

BENTHOS AND SEDIMENT COLLECTION AND PROCESSING

Benthic macroinvertebrate and sediment samples were collected on 16 April, 16 July, and 20 October 1980. Sixty samples were collected for benthos and sediments during each sampling month from the University of Michigan's R/V Mysis. During 1980, 180 benthic and sediment samples were collected.

Benthos and sediments were collected using a triplex (three-chambered) Ponar grab sampler (Mozley and Chapelsky 1973). Each chamber of the Ponar samples 0.0165 m^2. The contents of one side chamber were used to estimate numbers of benthic macroinvertebrates occurring in a square meter of lake bottom. Contents from the remaining two chambers were emptied into a tub and mixed, and approximately 30 g of sediment removed for sediment analysis. Six replicates were collected to estimate benthic populations and sediments at a station.

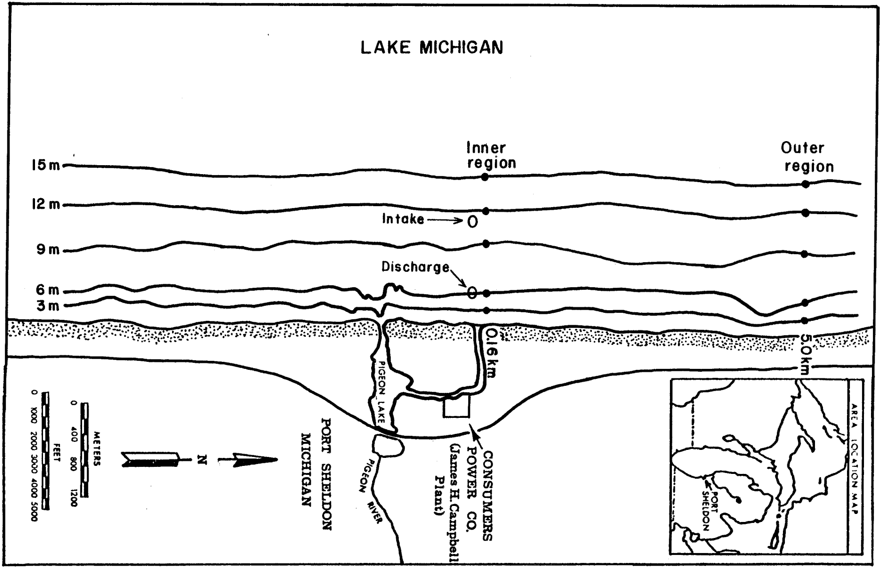

Fig. 1. Location of intake and discharge structures (open circles), stations (solid dots), regions (Inner = treatment area located 0.16 km north of intake and discharge structures, Outer = reference area located 5.0 km north of intake and discharge structures), and depths sampled in the 1980 benthos and sediment survey near the J. H. Campbell Plant, eastern Lake Michigan.

The portion of the sample used to estimate benthic macroinvertebrates was placed in a "funnel-shaped hopper" (see Mozley 1975 for details) aboard the R/V Mysis. Benthic samples were washed through a 0.2-mm mesh net to concentrate animals and remove excess sediment and debris. Concentrated samples were stored in labelled 0.5-liter Mason jars and preserved with carbonate-buffered, 4% formaldehyde solution. Samples were returned to the Great Lakes Research Division Benthos Laboratory for sorting and identification.

Sorting and initial identification of organisms were performed using dissecting microscopes (3-30X). Specimens unidentified at the genus/species level were mounted on slides with Amman's lactophenol clearing medium and identified using compound microscopes (40-1000X).

Initial generic identification of chironomids was determined using an unpublished trial key to the chironomids (A.L. Hamilton and O.A. Saether, personal communication, Freshwater Institute, Winnipeg, Manitoba, Canada and Zoological Museum and Department of Morphology, Systematics and Animal Ecology, University of Bergen, Bergen, Norway). Where species were determined for chironomid genera, "cf." refers to uncertain larval identification at the species level. Most species designations concur with reared specimens from the D.C. Cook Nuclear Power Plant, southeastern Lake Michigan (see Mozley 1975), which are maintained in the Great Lakes Research Division Benthos Laboratory's permanent collection. However, since none of the chironomid larvae from the Campbell Plant have been reared, identifications at the species level have been assigned the uncertainty designator "cf.". The designator "gr." refers to a "group" of species inseparable using early instar larval morphology and was associated with the genera *Chironomus*

and *Paracladopelma*. Morphology and taxonomy of other chironomid genera and species were determined from the following references: Lenz (1954), Roback (1957), Curry (1958), Beck and Beck (1969), Saether (1969, 1971, 1973, 1975, 1976, and 1977), Hirvenoja (1973), Maschwitz (1975), Jackson (1977), and Soponis (1977).

Naidids were identified using Hiltunen's key to the naidids (see Hiltunen and Klemm 1980). Tubificids were identified using an unpublished key to aquatic oligochaetes of the Great Lakes (J.K. Hiltunen, personal communication; Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service, Ann Arbor, Michigan). Gastropods and pelecypods were identified using a key to the mollusks of the Great Lakes (Mackie et al. 1980).

While aboard the R/V Mysis, sediments were stored in "Whirl-pack" bags bearing external labels. Standard mechanical sieving of sediment samples was performed at the Great Lakes Research Division Sediment Laboratory. Folk, Inman, and moment measure statistics were computed for each sample collected. Data were expressed in terms of phi units following Krumbein (1938). Upchurch (1969), Coakley and Beal (1972), and Seibel et al. (1974) indicated that moment measure statistics were the "preferred method for deriving sediment textural parameters." Two moment measure statistics, mean grain size and standard deviation of the mean grain size, were used in this report. Standard deviation was used as a measure of sorting, following Seibel et al. (1974). In addition to moment measure statistics, percentage of sediments occurring within any given sediment grain size based on units of phi was also included. Description of sediment grain sizes followed that of Seibel et al. (1974), who adapted theirs from the standard Wentworth scale.

RESULTS AND DISCUSSION

TOTAL BENTHOS

The nearshore Lake Michigan benthic community near J. H. Campbell Plant was characterized by 113 taxa from 1977 through 1980 (Table 1). Of major taxonomic groups present, the most diverse representatives were chironomids (44 taxa), pisidia (19 taxa), and naidids (18 taxa). Excluding the pilot study year (1977), 101 taxa were observed during subsequent years (Table 2). The number of taxa collected during 1980 (73) was similar to the number observed in 1978 (74), but lower than in 1979 (80). However, regardless of year, regions have had similar annual species richness, with 87 taxa identified from each region. In 1979 there was a striking difference between regions in the number of taxa found at 3 m. Neither this depth nor any of the remaining depths exhibited any appreciable differences during 1980, substantiating the suspicion that the difference in 1979 was temporary. With respect to depth, the number of taxa increased with increasing depth from a low of 40 taxa at 3 m to a high of 74 taxa at 12 and 15 m.

Similar to previous years, chironomids, turbellarians, and naidids were dominant at 3 and 6 m during 1980, while *Pontoporeia hoyi* generally was the predominant form at 9-15 m (Table 3). Other taxa, in particular tubificids, pisidia, and chironomids, constituted a significant portion of the benthic community at 9-15 m, in addition to *P. hoyi*. Large percent occurrence of chironomids at 12 and 15 m in April 1980 was not observed to the extent noted during April 1979.

The 1980 annual total benthic density estimate (6648 m^{-2}) was very similar to that of 1978 (6594 m^{-2}) (Table 4). Average benthic densities with respect to specific depths or months were quite similar. Mean

TABLE 1. Benthic macroinvertebrates identified from samples collected from 1977 through 1980 at 3 to 25 m near the J. H. Campbell Plant, eastern Lake Michigan.

- Coelenterata
  - Hydrozoa
    - Hydridae
      - *Hydra* sp.
- Platyhelminthes
  - Turbellaria
    - Unknown sp. 1
    - Unknown sp. 2
    - Unknown sp. 3
- Annelida
  - Oligochaeta
    - Enchytraeidae spp.
    - Lumbriculidae
      - *Stylodrilus heringianus*
    - Naididae
      - *Amphichaeta leydigii*
      - *Arcteonais lomondi*
      - *Chaetogaster diaphanus*
      - *Chaetogaster diastrophus*
      - *Chaetogaster setosus*
      - *Dero* sp. (?*digitata*)
      - *Nais communis*
      - *Nais elinguis*
      - *Nais pardalis*
      - *Nais simplex*
      - *Nais variabilis*
      - *Piguetiella michiganensis*
      - *Pristina foreli*
      - *Pristina osborni*
      - *Stylaria lacustris*
      - *Uncinais uncinata*
      - *Vejdovskyella intermedia*
    - Tubificidae
      - *Aulodrilus limnobius*
      - *Aulodrilus pigueti*
      - *Limnodrilus angustipenis*
      - *Limnodrilus claparedeianus*
      - *Limnodrilus hoffmeisteri*
      - *Limnodrilus profundicola*
      - *Limnodrilus spiralis*
      - *Limnodrilus udekemianus*
      - *Peloscolex freyi*
      - *Peloscolex superiorensis*
      - *Potamothrix moldaviensis*
      - *Potamothrix vejdovskyi*
      - *Rhyacodrilus coccineus*
  - Hirudinea
    - Glossiphoniidae
      - *Helobdella stagnalis*
    - Other Hirudinea spp.
- Arthropoda
  - Acari
    - Hydracarina spp.
  - Crustacea
    - Amphipoda
      - Gammaridae
        - *Gammarus* sp.
      - Haustoriidae
        - *Pontoporeia hoyi*
    - Mysidacea
      - Mysidae
        - *Mysis relicta*
  - Insecta
    - Diptera
      - Chironomidae
        - Chironominae
          - Chironomini
            - *Chironomus arthracinus*-gr.
            - *Chironomus fluviatilis*-gr.
            - *Chironomus halophilus*-gr.
            - *Cladopelma* sp.
            - *Cryptochironomus* sp. 1
            - *Cryptochironomus* sp. 2
            - *Cryptochironomus* sp. 3
            - *Cryptochironomus* cf. *rolli*
            - nr. *Cyphomella* sp.
            - *Dicrotendipes* sp.
            - *Endochironomus* sp.
            - *Glyptotendipes* sp.
            - *Parachironomus* cf. *abortivus*
            - *Paracladopelma* cf. *nereis*
            - *Paracladopelma* cf. *undine*
            - *Paracladopelma* cf. *winnelli*
            - *Paratendipes* sp.
            - *Phaenopsectra* sp.
            - *Polypedilum* cf. *tuberculum*
            - *Polypedilum* cf. *halterale*
            - *Polypedilum* cf. *scalaenum*
            - *Polypedilum* cf. *simulans*/*digitifer*
            - *Polypedilum* sp. 2
            - *Robackia* cf. *demeijerei*
            - *Saetheria* cf. *tylus*
          - Tanytarsini
            - *Cladotanytarsus* sp.
            - *Micropsectra* sp.
            - *Tanytarsus* sp.
        - Orthocladiinae
          - *Cricotopus* (*C.*) *tremulus*-gr.
          - *Cricotopus* (*C.*) sp.
          - *Cricotopus* (*C.*)/*Orthocladius* (*O.*) sp.
          - *Cricotopus* (*I.*) *sylvestris*-gr.
          - *Heterotrissocladius* cf. *changi*
          - *Heterotrissocladius* cf. *oliveri*
          - *Hydrobaenus* sp.
          - *Nanocladius* sp.
          - *Orthocladius* (*Euorthocladius*) sp.
          - orthocladiini sp. 2
          - *Paracladius* sp.
          - *Psectrocladius* cf. *simulans*
          - *Thienemanniella* sp.
        - Diamesinae
          - *Monodiamesa* cf. *tuberculata*
          - *Potthastia* cf. *longimanus*
        - Tanypodinae
          - *Procladius* sp.
    - Trichoptera
      - Molannidae
        - *Molanna* sp.
      - Leptoceridae
        - *Nectopsyche* sp.
      - Unidentifiable first instar
- Mollusca
  - Gastropoda
    - Ctenobranchiata
      - Hydrobiidae
        - *Amnicola* sp.
        - *Bythinia tentaculata*
        - *Somatogyrus* sp.
      - Valvatidae
        - *Valvata sincera*
    - Pulmonata
      - Lymnaeidae
        - *Lymnaea* sp.
  - Pelecypoda
    - Heterodonta
      - Sphaeriidae
        - *Pisidium adamsi*
        - *Pisidium casertanum*
        - *Pisidium compressum*
        - *Pisidium conventus*
        - *Pisidium fallax*
        - *Pisidium ferrugineum*
        - *Pisidium henslowanum*
        - *Pisidium idahoense*
        - *Pisidium lilljeborgi*
        - *Pisidium milium*
        - *Pisidium nitidum* f. *nitidum*
        - *Pisidium nitidum* f. *pauperculum*
        - *Pisidium subtruncatum*
        - *Pisidium supinum*
        - *Pisidium variabile*
        - *Pisidium walkeri*
        - *Sphaerium nitidum*
        - *Sphaerium striatinum*
        - *Sphaerium transversum*

TABLE 2. Number of identifiably different taxonomic units collected within each of the major taxonomic groups occurring at 3 to 15 m and for all depths combined in the inner and outer regions from 1978 to 1980. Samples were collected during April, July, and October of each year from eastern Lake Michigan near the J. H. Campbell Plant.

	3 m									6 m								
	Inner Region				Outer Region					Inner Region				Outer Region				
Taxon	1978	1979	1980	Total	1978	1979	1980	Total	Grand Total	1978	1979	1980	Total	1978	1979	1980	Total	Grand Total
Chironomidae	14	12	14	19	10	6	13	17	22	14	15	11	22	15	13	15	19	25
Naididae	6	8	6	10	3	2	5	7	11	7	9	7	12	7	7	9	10	13
Tubificidae	0	0	0	0	0	0	0	0	0	1	3	3	7	3	0	1	5	7
Pisidium	0	0	1	1	0	0	0	0	1	2	0	1	2	2	2	1	3	4
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	3
Others	2	2	2	3	1	3	5	6	6	4	3	4	7	2	5	4	6	7
Total	22	22	23	33	14	11	23	30	40	28	30	26	50	30	28	31	46	59

	9 m									12 m								
	Inner Region				Outer Region					Inner Region				Outer Region				
Taxon	1978	1979	1980	Total	1978	1979	1980	Total	Grand Total	1978	1979	1980	Total	1978	1979	1980	Total	Grand Total
Chironomidae	21	18	17	25	19	20	17	24	26	18	18	17	21	22	19	17	25	25
Naididae	7	8	7	9	10	9	9	11	11	6	11	7	11	7	10	8	12	13
Tubificidae	5	6	4	6	5	6	5	7	7	5	6	5	8	7	5	7	8	8
Pisidium	8	6	4	10	7	7	3	8	11	9	8	8	10	8	9	8	9	12
Sphaerium	1	0	0	1	1	0	0	1	2	0	2	1	2	1	1	1	1	2
Gastropoda	2	2	2	3	2	3	3	4	4	3	3	3	5	3	5	3	5	5
Others	6	4	7	9	5	5	7	7	9	5	4	5	8	5	6	5	8	9
Total	50	44	41	63	49	50	44	62	70	46	52	46	65	53	55	49	68	74

	15 m									All depths combined								
	Inner Region				Outer Region					Inner Region				Outer Region				
Taxon	1978	1979	1980	Total	1978	1979	1980	Total	Grand Total	1978	1979	1980	Total	1978	1979	1980	Total	Grand Total
Chironomidae	15	17	16	22	15	20	15	21	24	26	26	26	35	25	24	26	32	40
Naididae	9	8	9	11	9	7	7	10	12	10	12	10	14	11	10	10	14	16
Tubificidae	5	6	6	7	7	7	4	9	9	7	9	7	9	9	8	7	10	11
Pisidium	8	8	9	9	9	11	9	11	11	12	11	9	12	9	11	9	12	14
Sphaerium	1	2	1	2	2	3	1	3	3	1	2	1	2	2	3	1	3	3
Gastropoda	2	5	3	5	3	5	3	5	5	3	5	4	5	4	5	3	5	5
Others	6	6	6	7	7	8	5	9	10	7	7	9	10	7	10	9	11	12
Total	46	52	50	63	52	61	44	68	74	66	72	67	87	67	71	65	87	101

TABLE 3. Percent occurrence of major taxonomic groups collected in 1980 at 3 to 15 m among inner (treatment) and outer (reference) regions in the vicinity of the J. H. Campbell Plant, eastern Lake Michigan. Percentages expressed in terms of total benthos.

	April									
	Inner					Outer				
Taxon	3 m	6 m	9 m	12 m	15 m	3 m	6 m	9 m	12 m	15 m
Chironomidae	100.0		47.4	9.9	5.6	28.6	33.3	21.5	20.4	10.3
Naididae		40.0	2.1	1.9	0.7	28.6	41.7	6.5	2.7	0.5
Tubificidae		20.0	4.2	13.5	6.4			10.7	6.5	16.6
Enchytraeidae				0.3	0.5			2.0	8.5	9.3
Stylodrilus heringianus					0.6					5.9
Pisidium			1.1	7.1	6.7	28.6		2.8	17.7	15.9
Sphaerium				0.1						0.5
Gastropoda				1.0	0.7			0.8	1.0	2.6
Pontoporeia hoyi			40.0	65.3	78.2		8.3	53.7	37.8	35.9
Turbellaria				0.3	0.5			1.1	4.8	2.2
Others		40.0	5.2	0.6	0.1	14.3	16.7	0.8	0.7	0.1

	July									
	Inner					Outer				
Taxon	3 m	6 m	9 m	12 m	15 m	3 m	6 m	9 m	12 m	15 m
Chironomidae	84.3	24.2	14.1	4.1	2.8	88.2	51.4	24.2	5.3	2.7
Naididae	15.2	32.2	19.1	7.2	2.1	11.3	29.7	31.3	18.0	0.9
Tubificidae		3.3	3.2	4.7	4.0		6.4	12.8	14.7	7.1
Enchytraeidae		1.0	0.2	1.6	0.5		2.0	0.1	1.6	0.4
Stylodrilus heringianus			0.1	0.1	2.5				0.1	6.2
Pisidium		0.4	0.2	1.4	6.0		0.4	2.4	4.0	8.9
Sphaerium					0.4				0.3	0.1
Gastropoda			0.1		0.1			0.4	1.2	0.4
Pontoporeia hoyi	0.4	38.6	62.3	80.8	80.7	0.1	9.9	27.9	54.2	73.2
Turbellaria			0.4	0.1	0.6	0.3	0.2	0.1	0.4	0.1
Others		0.4	0.1		0.2			0.7	0.2	0.1

	October									
	Inner					Outer				
Taxon	3 m	6 m	9 m	12 m	15 m	3 m	6 m	9 m	12 m	15 m
Chironomidae	92.2	99.4	23.1	13.5	4.5	69.1	95.2	43.7	9.1	2.6
Naididae			51.2	13.3	1.3		1.2	40.6	8.3	1.1
Tubificidae			12.4	27.3	9.2			10.5	31.7	23.4
Enchytraeidae			1.5	2.4	4.3			0.9	10.8	3.7
Stylodrilus heringianus					2.2			0.1		15.7
Pisidium	1.1		1.2	13.3	12.6		1.2	0.6	15.2	18.6
Sphaerium				0.2	0.3				0.2	0.4
Gastropoda			1.0	7.6	5.3		1.2	0.4	5.0	3.2
Pontoporeia hoyi	4.4	0.6	6.7	19.4	59.0			1.1	16.5	29.9
Turbellaria			2.7	2.8	0.9	30.1	1.2	1.3	3.1	1.2
Others	2.2				0.3	0.8		0.9	0.2	0.1

TABLE 4. Annual mean density (no. m^{-2}) and frequency of occurrence of major taxonomic groups (n = 180 yr^{-1}) collected from 1978 to 1980 in eastern Lake Michigan near the J. H. Campbell Plant.

	Mean density				Frequency of occurrence			
Taxon	1978	1979	1980	1978-1980	1978	1979	1980	1978-1980
Pontoporeia hoyi	1602	2883	2955	2480	60.0	78.9	69.4	69.4
Mysis relicta	0	<1	0	<1	0.0	0.6	0.0	0.2
Chironomidae	2224	1204	1473	1634	95.0	94.4	87.8	92.4
Naididae	1128	1783	708	1206	75.6	71.1	65.0	70.6
Tubificidae	886	735	627	749	63.3	64.4	58.3	62.0
Enchytraeidae	68	189	125	128	16.7	42.8	33.9	31.1
Stylodrilus heringianus	131	96	159	128	18.9	14.4	19.4	17.6
Oligochaeta	2213	2803	1619	2211	78.3	79.4	74.4	77.4
Gastropoda	71	94	81	82	35.6	37.8	32.8	35.4
Pisidium	266	478	416	387	53.9	52.2	55.6	53.9
Other Pelecypoda	6	4	10	7	6.7	6.1	11.7	8.1
Pelecypoda	272	482	426	394	54.4	52.2	55.6	54.1
Hirudinea	4	2	5	4	5.0	2.2	5.0	4.1
Hydracarina	9	4	3	5	10.6	4.4	4.4	6.5
Hydra	5	7	4	5	6.1	2.8	5.0	4.6
Turbellaria	193	461	76	244	32.2	64.4	34.4	43.7
Other Insecta	<1	<1	6	2	0.6	0.6	7.2	2.8
Total benthos	6594	7940	6648	7061	95.6	96.7	92.8	95.0

benthic abundance generally increased with depth during all 3 yr (Fig. 2); lowest monthly density occurred in April, and the highest was in July, while densities decreased somewhat by October (Fig. 3). While several of the regional mean total benthic density comparisons were considerably different in 1979, similar estimates in 1980 suggested a pattern like that observed during 1978, with no striking differences between inner and outer total benthic abundance (Fig. 4 and Appendix 1). Nonetheless, based on these 3 yr, there was a consistent regional trend shown by certain groups comprising the total benthic estimate. The group which exhibited the most marked regional trend was _P. hoyi_. Averaged over all samples in each region (n = 270), _P. hoyi_ inner region mean abundance was 2808 m^{-2}, comprising 42% of the benthos; this percentage has steadily increased from 1978 (30%) to 1980 (58%). In the outer region, mean abundance of _P. hoyi_ (2152 m^{-2}) was not considerably different from the inner region, but percent occurrence was only 29%, demonstrating an annual change from 20% in 1978 to 32% in 1980 (Table 5). Although none of the remaining major taxonomic groups in the outer region accounted for large proportions of the difference between regions, all were equally abundant or slightly more numerous than their counterparts in the inner region. Of these groups oligochaetes, turbellarians, and chironomids tended to be more abundant in the outer region than in the inner region. Most notable was the steady decline in percent occurrence of tubificids in the inner region, while in the outer region this percentage remained fairly stable from 1978 to 1980. These data represent the preoperational status of the regional benthic communities, the significance of which will be addressed later.

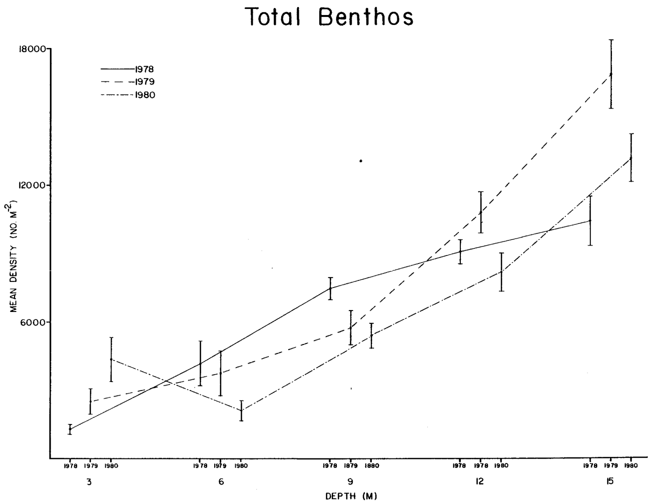

Fig. 2. Mean density (number m^{-2}) of total benthos collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

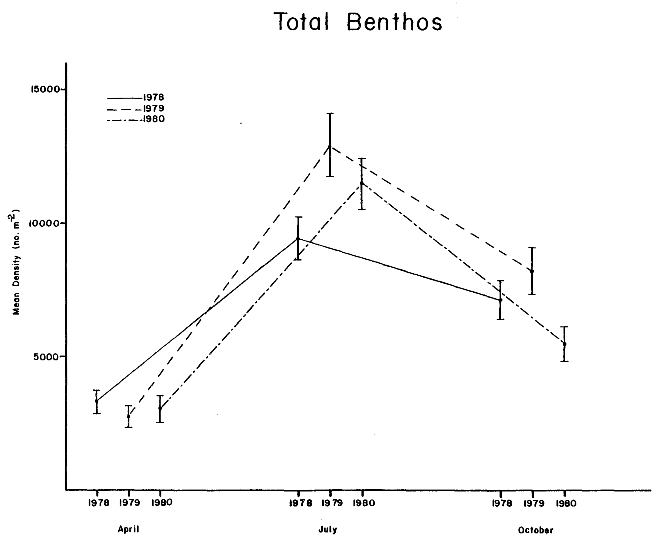

Fig. 3. Mean density (number m^{-2}) of total benthos collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

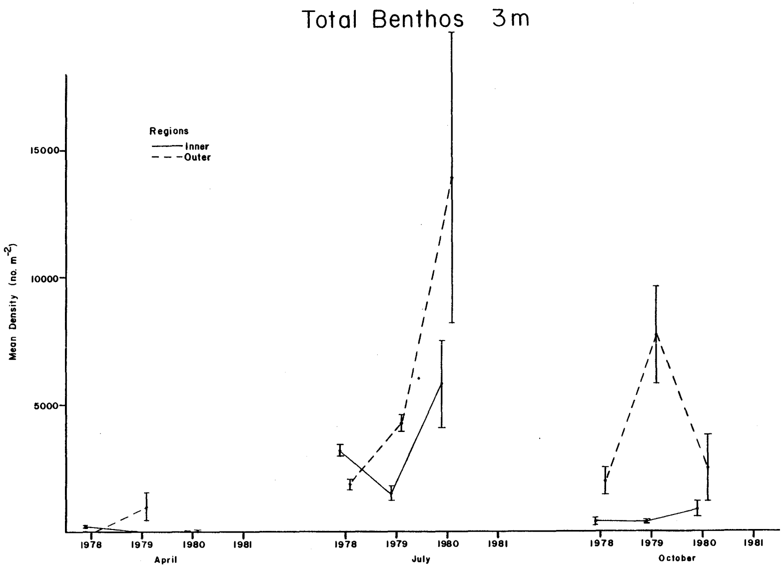

Fig. 4. Inner and outer regional mean densities (number m^{-2}) of total benthos collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 3-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

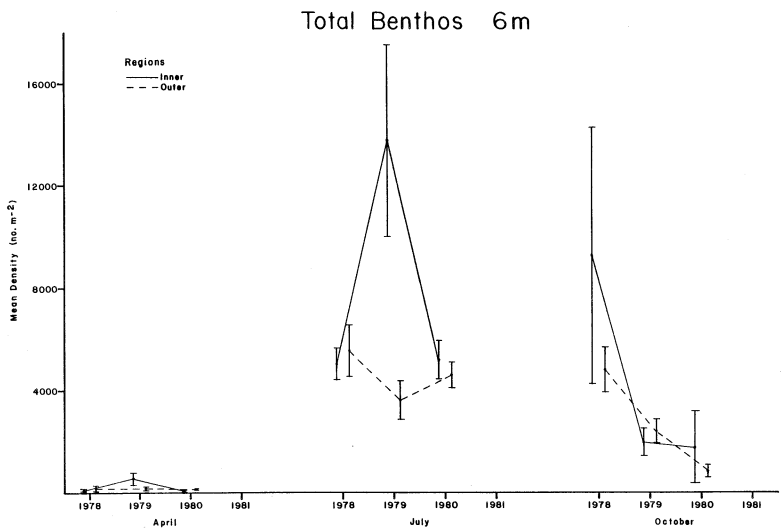

Fig. 4. Continued.

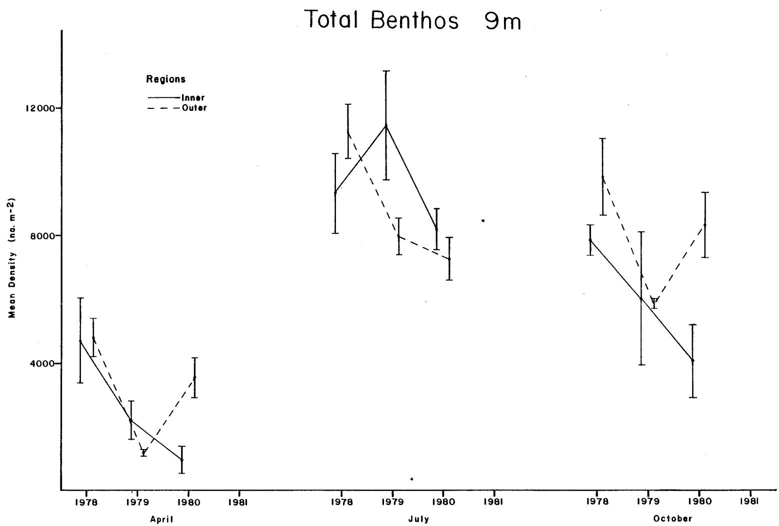

Fig. 4. Continued.

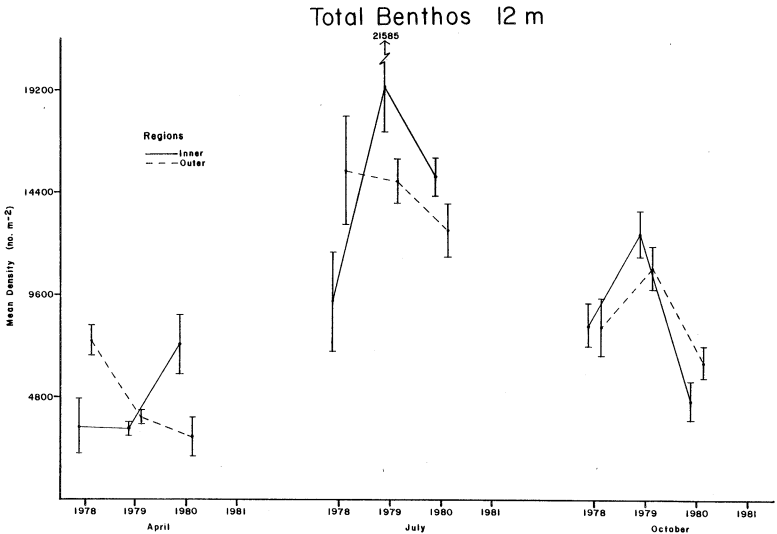

Fig. 4. Continued.

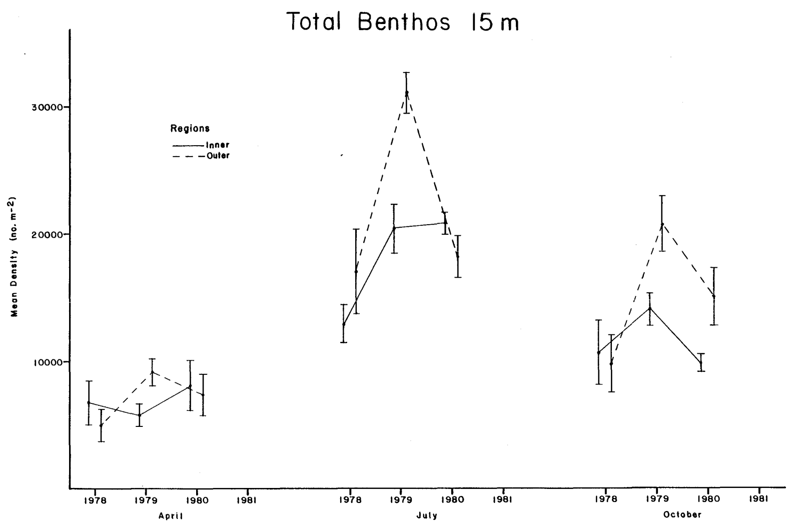

Fig. 4. Continued.

TABLE 5. Annual percentage of total benthos and mean density (no. m^{-2}) for major taxonomic groups collected from 1978 to 1980 from the inner (treatment) and outer (reference) regions (n = 90 $region^{-1}$ yr^{-1}) near the J. H. Campbell Plant, eastern Lake Michigan.

	Inner Region							
	Percentage of total benthos				Mean density			
Taxon	1978	1979	1980	1978-1980	1978	1979	1980	1978-1980
Pontoporeia hoyi	29.5	38.8	58.2	42.2	1851.7	2929.7	3642.1	2807.8
Mysis relicta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chironomidae	34.6	12.9	16.7	21.4	2178.2	974.3	1047.7	1400.1
Naididae	14.8	28.9	9.5	17.7	929.2	2182.9	592.5	1234.9
Tubificidae	12.2	7.3	6.6	8.7	771.6	549.4	414.8	578.6
Enchytraeidae	0.9	1.7	1.1	1.2	59.3	128.6	71.4	86.4
Stylodrilus heringianus	1.4	0.5	0.9	0.9	85.5	34.3	53.9	57.9
Oligochaeta	29.3	38.4	18.1	28.6	1845.6	2895.3	1132.5	1957.8
Gastropoda	1.0	1.1	1.2	1.1	62.6	80.8	72.0	71.8
Pisidium	3.7	5.3	4.8	4.6	231.6	402.7	300.0	311.4
Other Pelecypoda	0.1	<0.1	0.1	0.1	3.4	3.4	8.8	5.2
Hirudinea	<0.1	0.0	0.1	<0.1	2.0	0.0	4.7	2.2
Hydracarina	0.1	0.1	<0.1	0.1	8.8	5.4	2.7	5.6
Hydra	<0.1	0.2	<0.1	0.1	2.7	14.1	2.0	6.3
Turbellaria	1.6	3.3	0.6	1.8	100.3	250.5	37.0	129.3
Other Insecta	0.0	0.0	0.1	<0.1	0.0	0.0	6.7	2.2
Total benthos					6286.9	7556.2	6256.2	6699.8

	Outer Region							
	Percentage of total benthos				Mean density			
Taxon	1978	1979	1980	1978-1980	1978	1979	1980	1978-1980
Pontoporeia hoyi	19.6	34.1	32.2	29.0	1352.1	2836.8	2267.1	2152.0
Mysis relicta	0.0	<0.1	0.0	<0.1	0.0	1.3	0.0	0.4
Chironomidae	32.9	17.2	27.0	25.2	2269.8	1432.9	1898.8	1867.2
Naididae	19.2	16.6	11.7	15.9	1325.8	1382.4	822.8	1177.0
Tubificidae	14.5	11.1	11.9	12.4	1000.6	920.5	839.0	920.0
Enchytraeidae	1.1	3.0	2.6	2.3	77.4	249.8	180.5	169.2
Stylodrilus heringianus	2.6	1.9	3.7	2.7	176.4	156.9	263.3	198.9
Oligochaeta	37.4	32.6	29.9	33.2	2580.2	2709.6	2105.6	2465.1
Gastropoda	1.2	1.3	1.3	1.2	79.5	106.4	89.6	91.8
Pisidium	4.4	6.6	7.6	6.2	301.0	553.5	531.9	462.1
Other Pelecypoda	0.1	0.1	0.2	0.1	9.4	4.7	11.4	8.5
Hirudinea	0.1	<0.1	0.1	0.1	6.7	3.4	4.7	4.9
Hydracarina	0.1	<0.1	<0.1	0.1	8.8	3.4	3.4	5.2
Hydra	0.1	0.0	0.1	0.1	6.7	0.0	6.7	4.5
Turbellaria	4.1	8.1	1.6	4.8	286.2	671.3	115.8	357.8
Other Insecta	<0.1	<0.1	0.1	<0.1	0.7	0.7	5.4	2.3
Total benthos					6901.1	8324.0	7040.4	7421.8

CHIRONOMIDAE

While 44 chironomid taxa were identified from the survey area from 1977 to 1980, only 40 of these taxa were observed during the latter 3 yr (Table 1). From 1978 to 1980 the inner region was represented by 35 chironomid taxa and the outer region by 32 chironomid taxa. Both regions were represented by 26 chironomid taxa during 1980 (Table 2). The only significant change in chironomid taxonomy from previous years has been to tentatively speciate the *Polypedilum fallax*-gr. individuals to *Polypedilum* cf. *tuberculum* (see Maschwitz 1975).

Although dominance of *Saetheria* cf. *tylus* and *Paracladopelma camptolabis*-gr. in the survey may occasionally vary, these two chironomid taxa were consistently the dominant chironomids (24% and 16%, respectively) from 1978 to 1980. For example, in 1980 large densities of *Psectrocladius* cf. *simulans* were encountered, making it the most numerous chironomid in 1980, although it did not occur very frequently. In the inner region, *S.* cf. *tylus* was the dominant chironomid during all 3 yr, while in the outer region dominance was shared by three different chironomid taxa, with *S.* cf. *tylus* the second- or third-most abundant chironomid taxon (Appendix 2).

Although chironomids were represented by a similar frequency in samples collected during 1980 (88%) when compared with 1978 (95%) and 1979 (94%) (Table 4), abundance continued to exhibit considerable monthly and depth variability on an annual basis. Mean chironomid density in 1980 (1473 m^{-2}) was similar to that observed during 1979 (1204 m^{-2}); both were considerably less than 1978 levels (2224 m^{-2}), particularly from 6 to 12 m. Notably different in 1980 was the low chironomid density in April and high chironomid density in July

(Fig. 5), and at the 3-m depth, regardless of month (Fig. 6). Low abundance in April was due primarily to changes in _S_. cf. _tylus_ density resulting from weathering and survival from the previous year. Unusually high chironomid density during July and at the 3-m depth were produced by two samples which retained second instar _Psectrocladius_ cf. _simulans_ (15,271 and 34,542 m^{-2}) in very large abundances and accounted for approximately one-third of these density estimates. Abundances of this magnitude for _P_. cf. _simulans_ are believed to be the greatest noted in the Great Lakes and were likely a chance occurrence associated with undispersed larvae from a recently deposited egg mass(es).

Regional comparisons of chironomid abundance in 1980 suggested similar regional fluctuations with the exception of October at 9 m (Fig. 7). The inner/outer regional difference at 9 m in October was due to greater abundance of _Paracladopelma_ _camptolabis_-gr. in the outer region. Regional densities during 1980 more closely resembled those of 1979 than 1978. Large differences in chironomid abundance at 15 m in April 1980 when compared with 1978 and 1979 were mostly due to decreased density of _Saetheria_ cf. _tylus_. We speculated that comparatively large densities of _S_. cf. _tylus_ in April 1979 at 15 m were caused by scouring of shallower depths due to spring ice break-up and storm activity. However, the weathering process as an explanation for observed differences may be incidental to the fact that reproduction and survival from 1979 to 1980 may have been considerably less than that which occurred from 1978 to 1979, resulting in lower densities in April 1980.

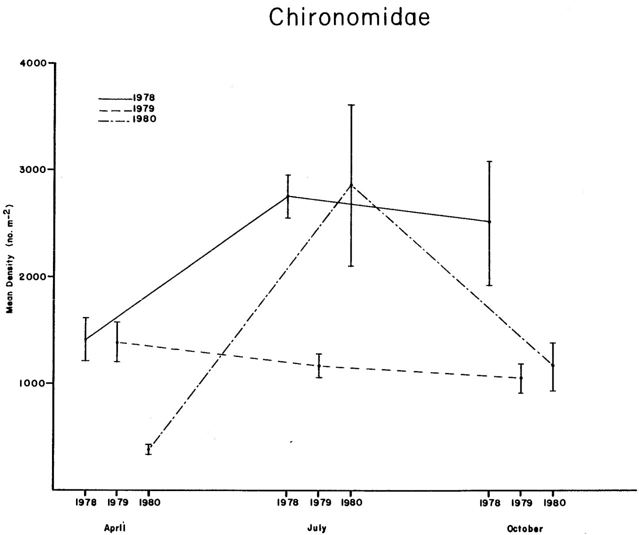

Fig. 5. Mean density (number m^{-2}) of chironomids collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

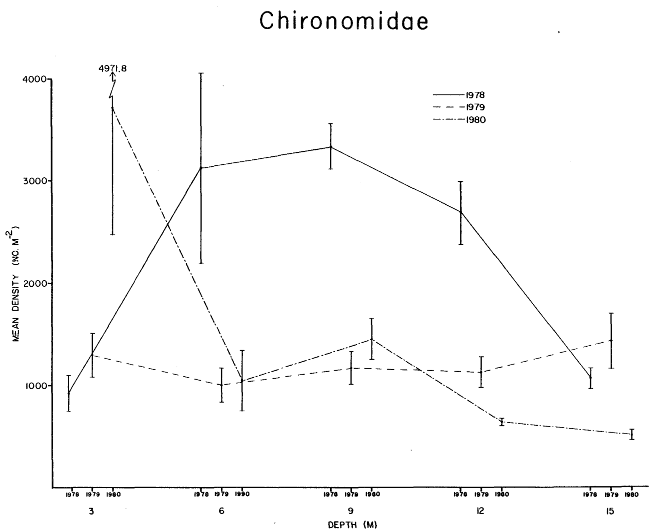

Fig. 6. Mean density (number m^{-2}) of chironomids collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

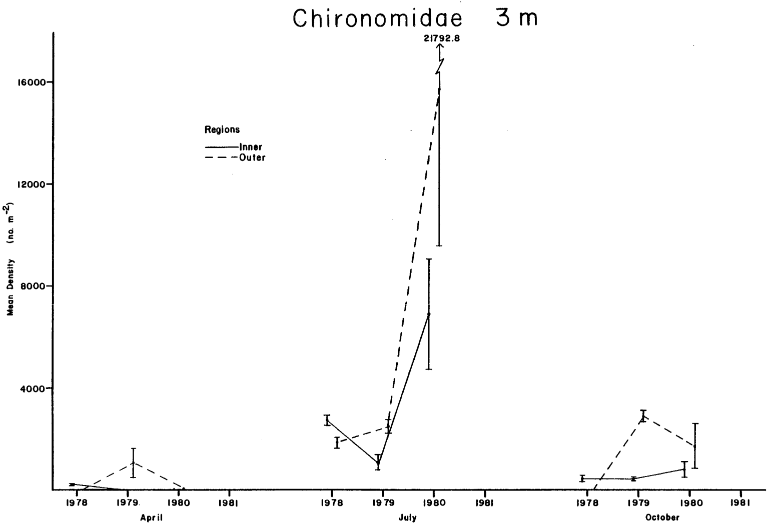

Fig. 7. Inner and outer regional mean densities (number m^{-2}) of chironomids collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 3-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

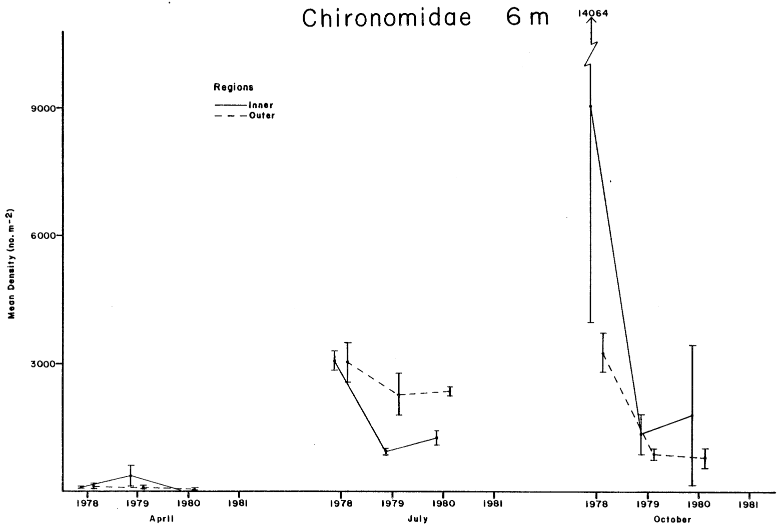

Fig. 7. Continued.

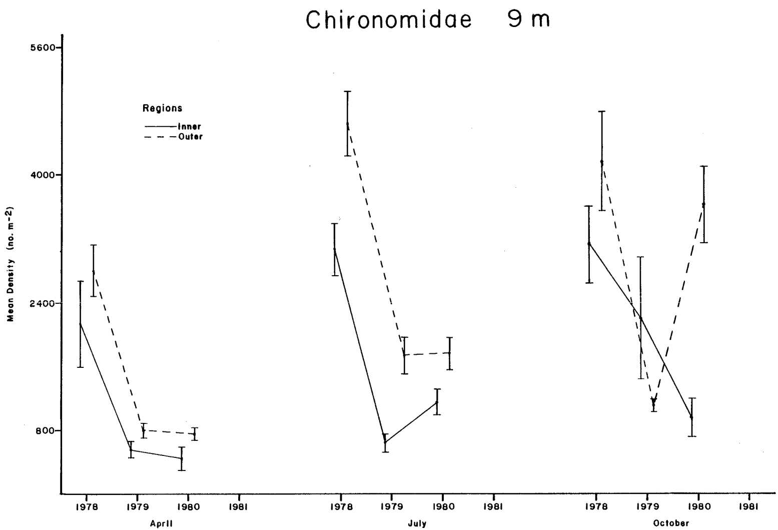

Fig. 7. Continued.

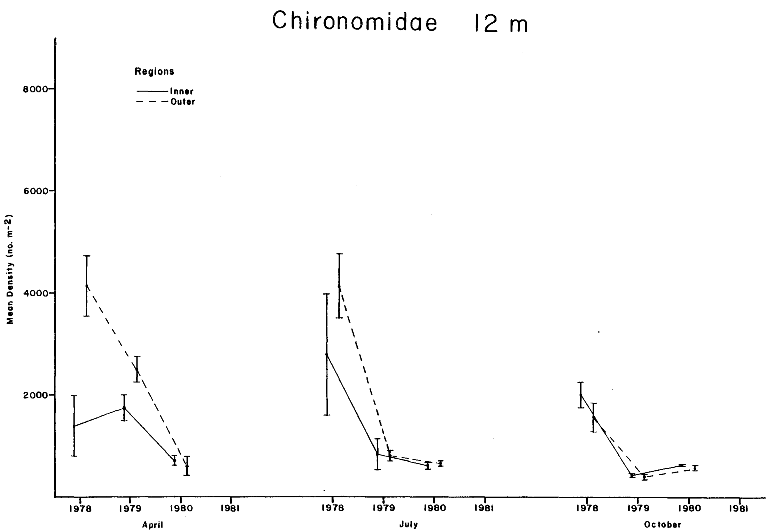

Fig. 7. Continued.

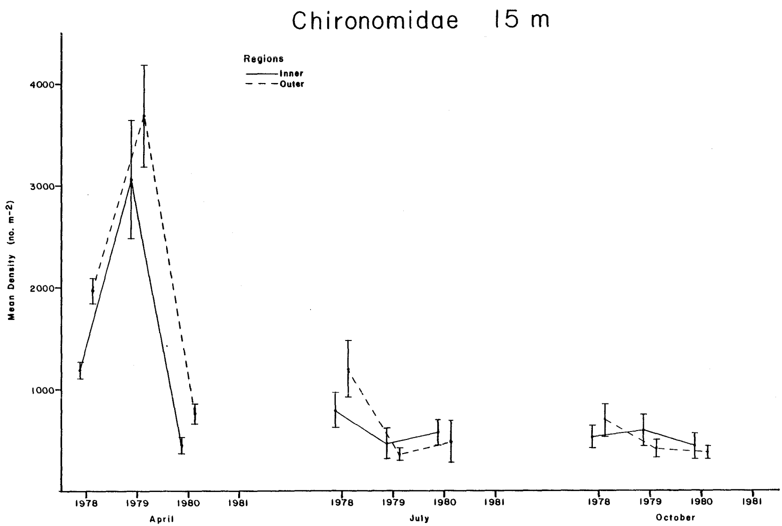

Fig. 7. Continued.

NAIDIDAE

From 1977 to 1980, naidids were represented by 17 taxa; 16 were collected during years after the pilot study year (1977) (Table 1). Each region has had 14 naidid taxa identified from 1978 to 1980 of which 10 taxa were present during 1980 (Table 2). With the exception of the very large abundances of *Vejdovskyella intermedia* in 1979, particularly in the inner region during July, *Piguetiella michiganensis* was the most abundant and frequently occurring naidid in the survey area. During 1980, the naidid *Nais variabilis* was the second-most numerous naidid (Appendix 3), even though previously it was rather scarce in the survey area.

Lowest annual naidid density was observed during 1980 (708 m^{-2}) when compared with previous years (Table 4). Likewise, percent occurrence in samples collected decreased to 65% in 1980 from a high of 76% in 1978. The 1980 pattern of monthly and depth density estimates most clearly resembled that observed during 1978, with the general trend being one of declining naidid density from 1978 to 1980 (Figs. 8 and 9).

Regional naidid density comparisons indicated the naidid population was similarly numerous within regions at each depth considered. In addition, annual fluctuations of naidids at each depth were similar in both regions (Fig. 10). Although large density decreases for naidids were observed in July and October 1980 at 12 m, low abundances were observed in both regions, thereby suggesting the causes for the decline were operating equally across regions. Finally, large regional density discrepancies noted at 6 and 9 m in July 1979 and ascribed to construction activity impact appeared to have been ameliorated in 1980 as had been expected.

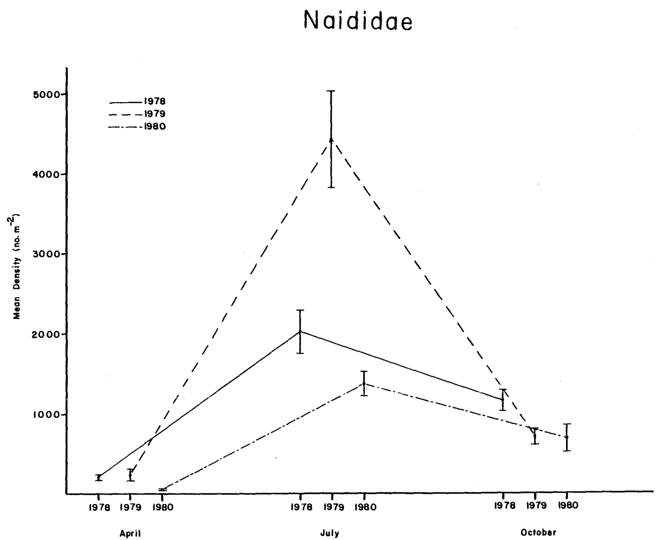

Fig. 8. Mean density (number m^{-2}) of naidids collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

Naididae

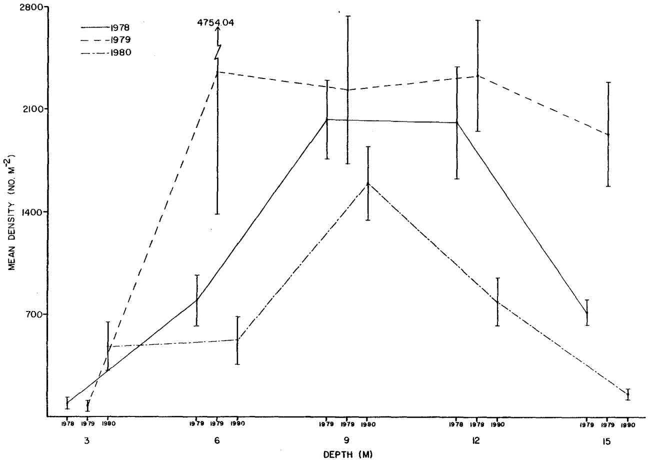

Fig. 9. Mean density (number m^{-2}) of naidids collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

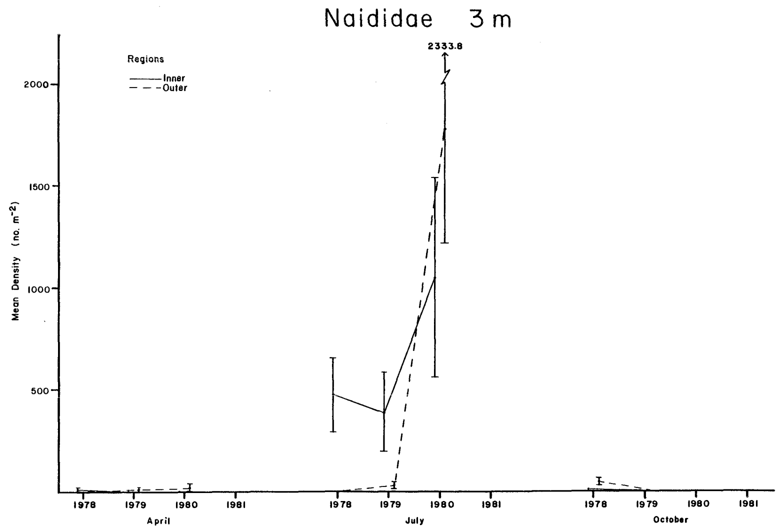

Fig. 10. Inner and outer regional mean densities (number m^{-2}) of naidids collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 3-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

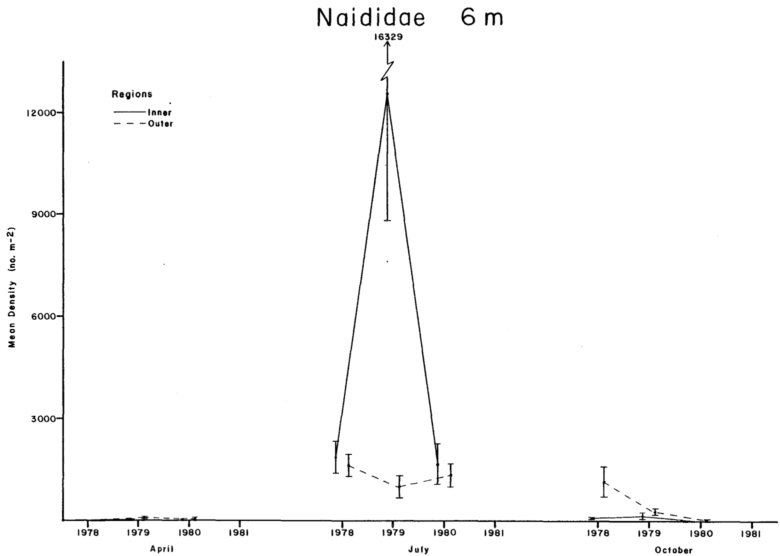

Fig. 10. Continued.

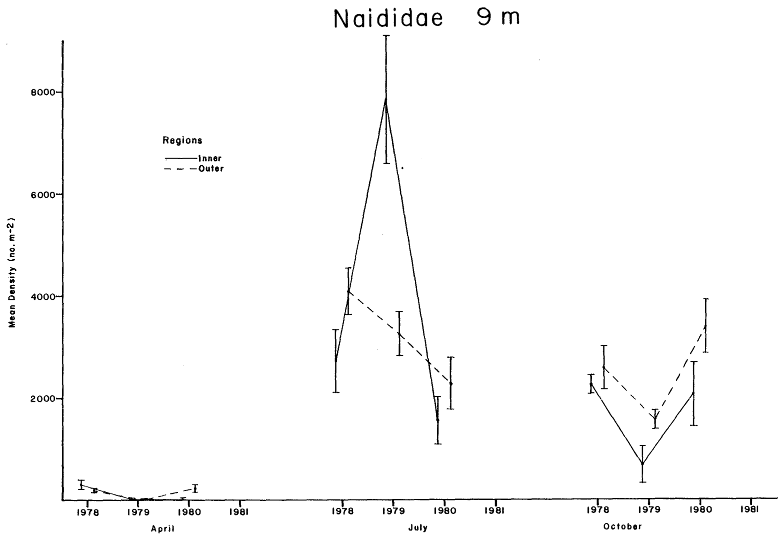

Fig. 10. Continued.

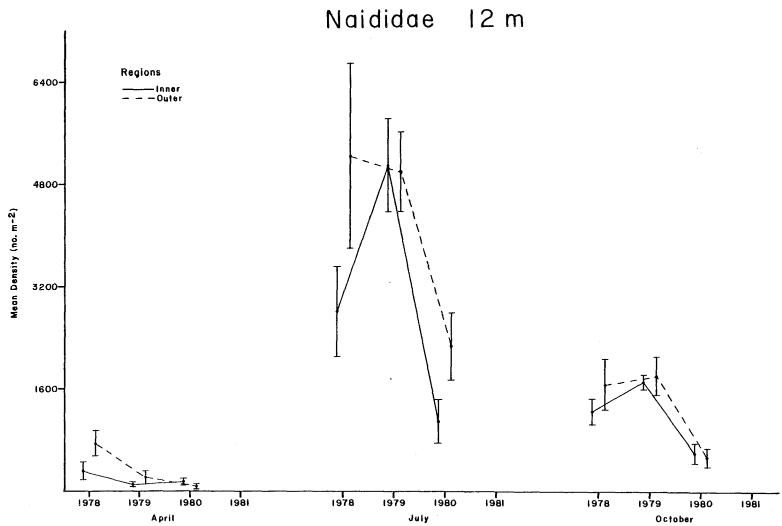

Fig. 10. Continued.

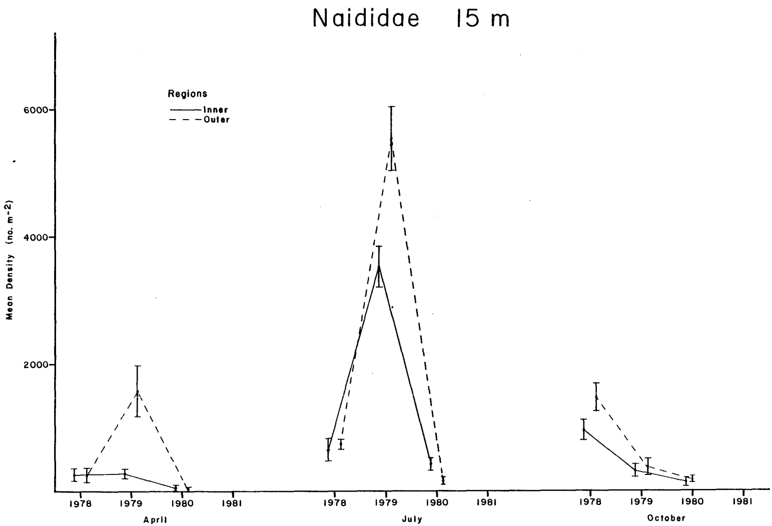

Fig. 10. Continued.

TUBIFICIDAE

Tubificids were represented by 13 taxa from 1977 to 1980, but only 11 of these were collected during the latter 3 yr (Tables 1 and 2). Seven tubificid taxa were observed in each region during 1980, bringing the total number of tubificid taxa in the inner region to 9 and the outer region to 10. Potamothrix moldaviensis was the most abundant tubificid during each year and was similarly numerous during all years in each region, except 1979 in the inner region.

Annual mean tubificid density (627 m^{-2}) and percent occurrence in benthic samples (58%) during 1980 were the lowest annual values observed in the survey area from 1978 to 1980 (Table 4). Although there was a slight decrease in annual tubificid abundance, the distributional pattern of mean monthly densities and mean depth densities continued to be very similar during each year (Figs. 11 and 12).

While annual tubificid abundances decreased in both regions from 1978 to 1980, the decline was comparatively greater in the inner (46%) than in the outer (16%) region. Although regional density estimates for tubificids indicated greater abundance in the outer as opposed to the inner region at 12 and 15 m during most months sampled (Fig. 13, Appendix 3), most of these differences were not extreme. However, the most disparate of these regional differences occurred in October at 15 m where tubificid numbers continued to increase in the outer region and decrease in the inner region from 1978 to 1980. Continuation of the October, 15-m regional difference can at present be ascribed to no other cause than inherent differences between the two regions. Remaining regional differences were likely of little significance, given that tubificid densities are normally very patchily distributed.

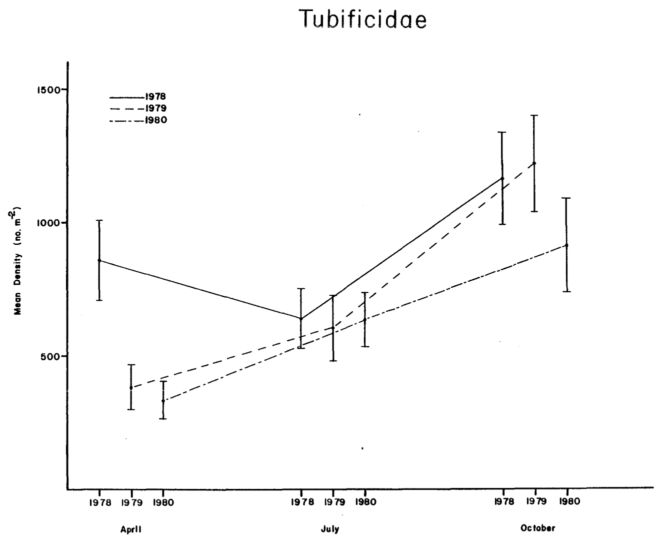

Fig. 11. Mean density (number m^{-2}) of tubificids collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

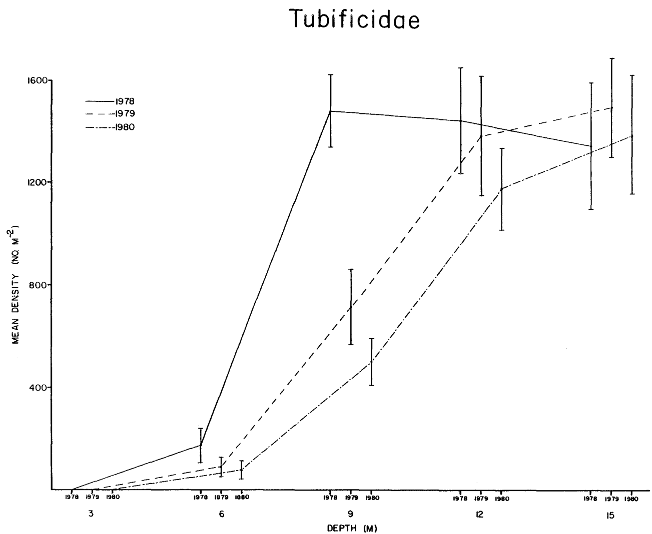

Fig. 12. Mean density (number m^{-2}) of tubificids collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

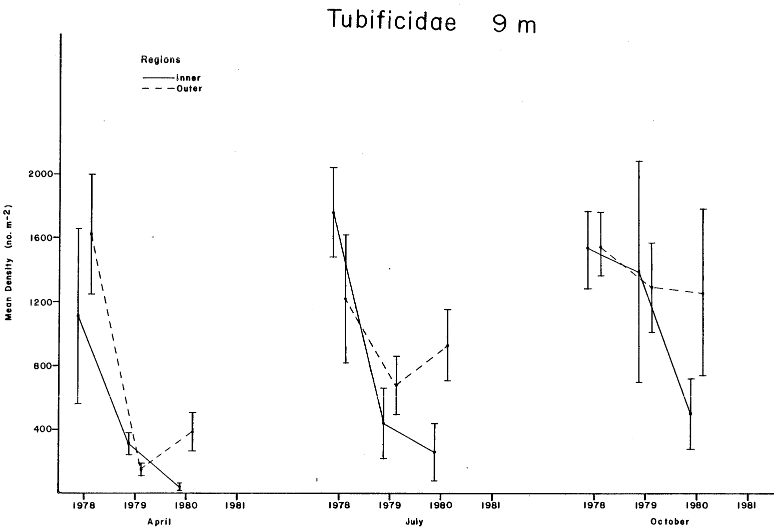

Fig. 13. Inner and outer regional mean densities (number m^{-2}) of tubificids collected in April. July, and October 1978 through 1980 from eastern Lake Michigan at 9-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

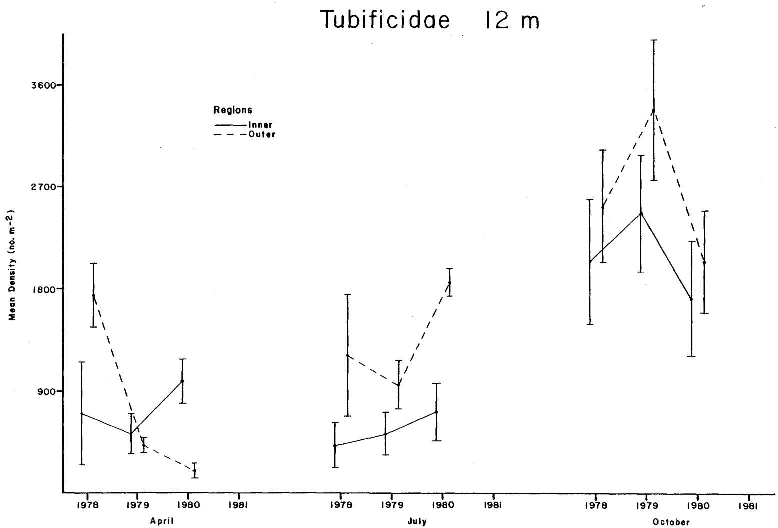

Fig. 13. Continued.

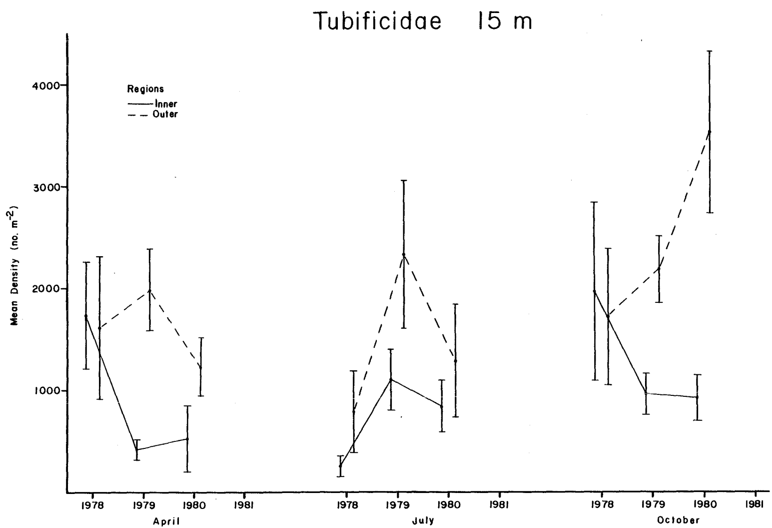

Fig. 13. Continued.

ENCHYTRAEIDAE

Enchytraeids were represented by at least two species in 34% of the samples collected during 1980, having an annual mean density of 125 m^{-2} (Table 4). Both frequency of occurrence and abundance population parameters for 1980 enchytraeids were intermediate to those of previous years, with 1979 being by far the most abundant year for enchytraeids. While deviating slightly from previous years, enchytraeid abundance with respect to month and depth generally concurred with distribution patterns observed in 1978 and 1979 (Figs. 14 and 15). Regionally, greatest enchytraeid density differences during 1980 were at 15 m in April and 12 m in October. Both of the regional density differences were of temporary duration. The former difference was no longer evident by July 1980. The latter regional difference, although requiring April 1981 data for confirmation, was suspected to follow a pattern similar to that noted from October 1979 to April 1980 at 12 m, i.e., minimal difference, followed by no difference in July 1980 at 12 m (Fig. 16, Appendix 3).

STYLODRILUS HERINGIANUS

Occurrence of *Stylodrilus heringianus* in the survey area was limited almost exclusively to 15 m in 1980 as well as during other years (Appendix 3). *S. heringianus* was collected in 19% of the samples during 1980, which was comparable to values observed in previous years (Table 4). Greatest annual mean abundance of *S. heringianus* was observed during 1980 (159 m^{-2}), although this value was not much greater than those observed during 1978 and 1979 (131 m^{-2} and 94 m^{-2}, respectively). The same distributional pattern was observed in the survey area with

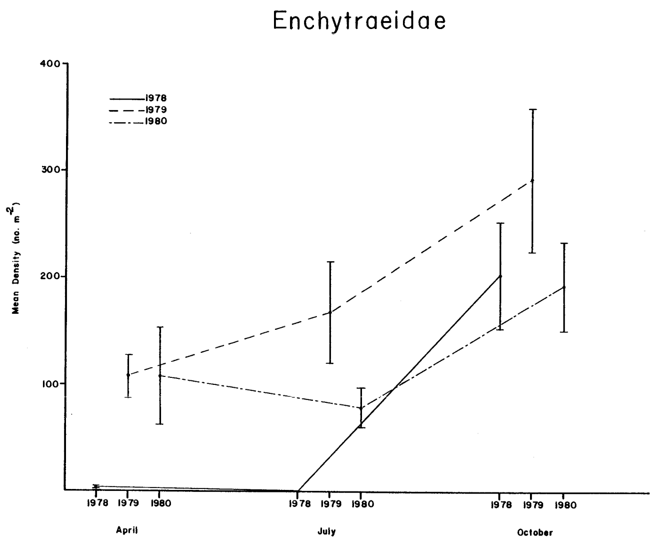

Fig. 14. Mean density (number m^{-2}) of enchytraeids collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

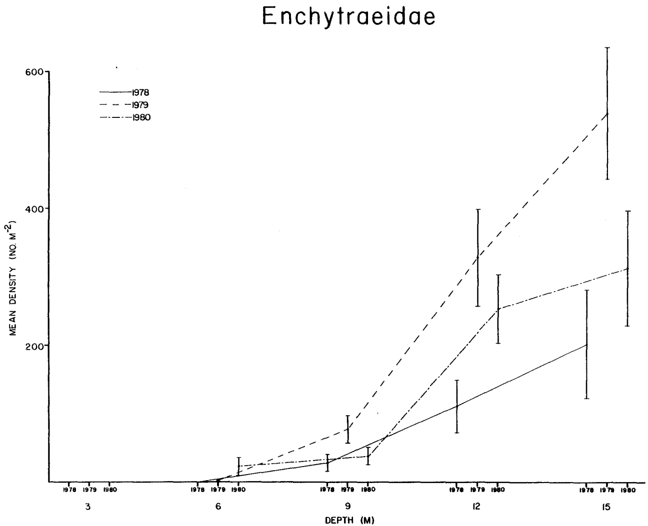

Fig. 15. Mean density (number m^{-2}) of enchytraeids collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

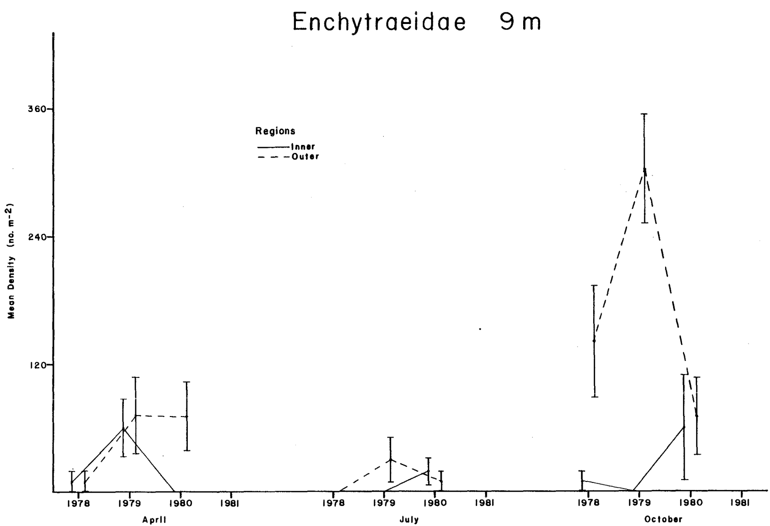

Fig. 16. Inner and outer regional mean densities (number m^{-2}) of enchytraeids collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 9-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

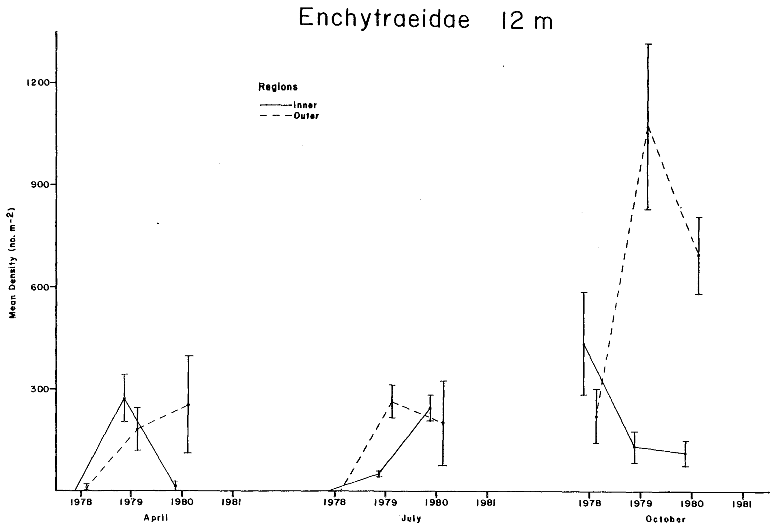

Fig. 16. Continued.

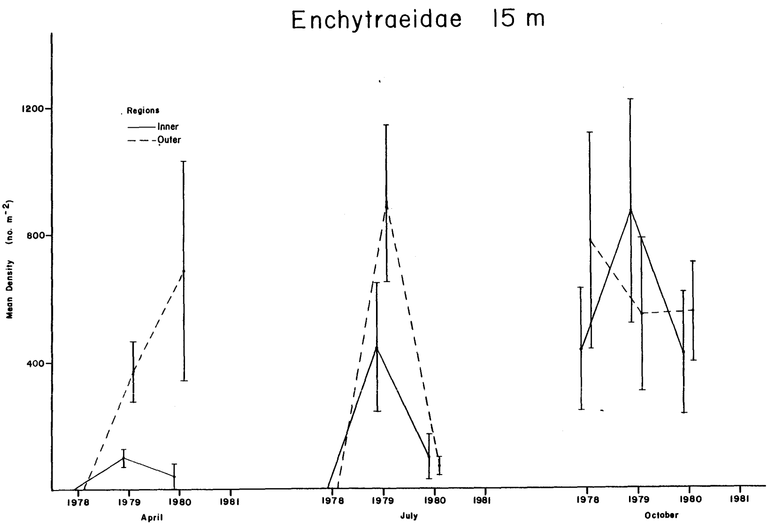

Fig. 16. Continued.

respect to month (gradual increase in abundance from April to October in response to reproductive activity) and depth (greatest abundance at 15 m) during all 3 yr (Figs. 17 and 18). However, based on a 3-yr estimate, *S. heringianus* was consistently more numerous in the outer (199 m^{-2}) than in the inner (58 m^{-2}) region (Table 5).

Comparison of *S. heringianus* regional mean abundance suggested no disparate trends during 1980, except at 15 m in October (Fig. 19). *S. heringianus* density increased over two-fold at 15 m during October in the outer region from approximately 1000 m^{-2} in 1978 to nearly 2400 m^{-2} in 1980. In the inner region, however, abundance of *S. heringianus* decreased from approximately 1000 m^{-2} in 1978 to less than 250 m^{-2} during 1980. In contrast to October, regional *S. heringianus* densities during April and July at 15 m were similar. Therefore, even though October regional differences at 15 m were increasingly disparate with each successive year, these dissimilarities have not resulted in any consistent regional trends during other months and years. No explanation can be offered at present to clarify the cause of this trend other than inherent differences between regions.

TURBELLARIA

Three unknown turbellarian forms were identified from the survey area. As in 1979, the species 1 form was dominant at 3 and 6 m, with the species 2 form generally most numerous at remaining depths (Appendix 1). Species 3 was also found at 9-15 m but in very low densities. Aside from these similarities, dissimilarity appeared to be the standard, as annual variation of turbellarian density was very extreme from 1978 to 1980. Frequency occurrence decreased from a maximum

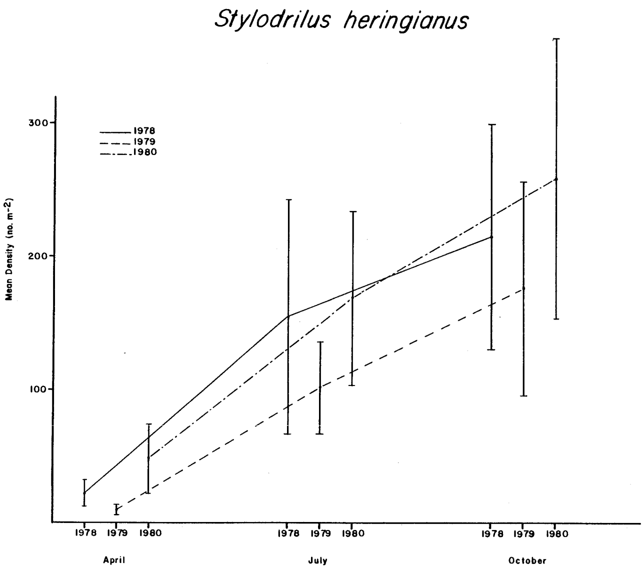

Fig. 17. Mean density (number m^{-2}) of S. heringianus collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

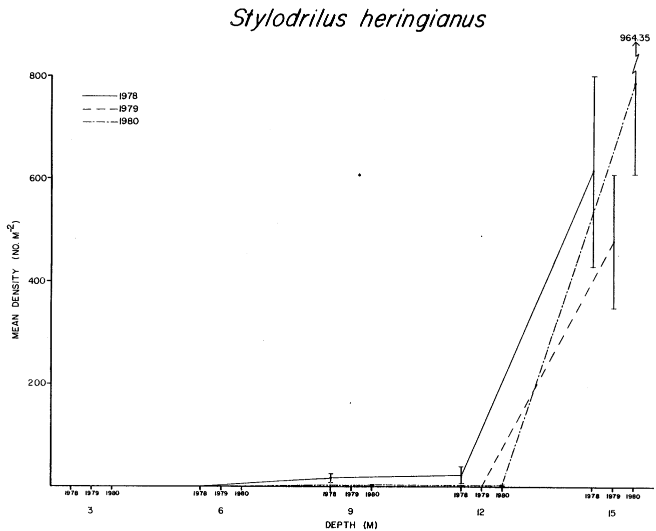

Fig. 18. Mean density (number m^{-2}) of S. heringianus collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

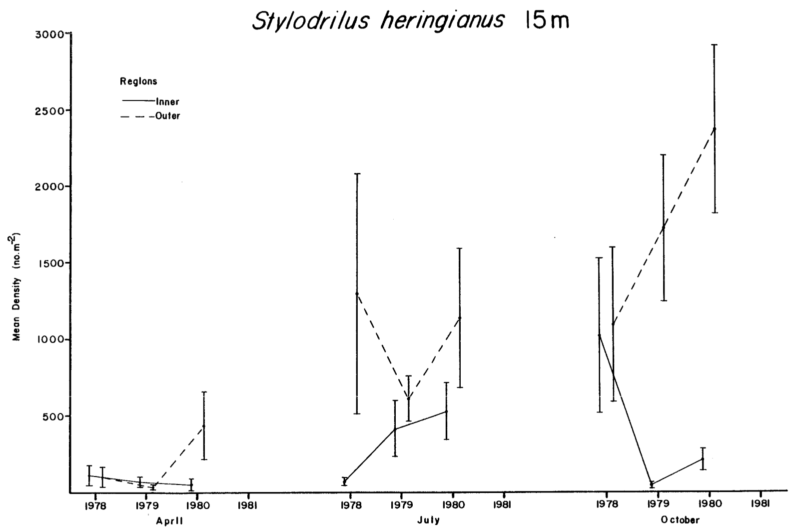

Fig. 19. Inner and outer regional mean densities (number m^{-2}) of S. heringianus collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

observed in 1979 (64%) to 34% in 1980, almost the same as that observed during 1978. Average annual abundance decreased substantially from 461 m^{-2} in 1979 and 193 m^{-2} in 1978 to 76 m^{-2} in 1980 (Table 4). Although October abundance during 1980 was lower, the turbellarian seasonal distribution pattern in 1980 was similar to 1978 (Fig. 20). Turbellarian densities across depths were very similar during 1980, with fewest collected at 6 m. While resembling the 1978 density trend with depth more closely than that of 1979, the number of turbellarians occurring at any given depth was unpredictable (Fig. 21), except at 6 m where lowest abundances occurred during each year.

Outer region turbellarian densities (358 m^{-2}) were consistently greater than inner region values (129 m^{-2}) based on a 1978-1980 average (Table 5). While this regional difference persisted for turbellarians in general in the survey area, it was most evident at 3 m during July and October during all 3 yr (Fig. 22). Other depth and month combinations demonstrated temporary regional disparities which were minimized during succeeding months or years.

PELECYPODA

Three genera and 17 species of pelecypods were found in the survey area from 1977 to 1980. The majority of pelecypod species belong to the genus *Pisidium* (14 species), with two species of *Sphaerium* and a single species of *Musculium* also represented (Table 1). Although occurring in 54% of samples collected, pelecypods comprised only a small portion of the benthic population (5.6%) (Table 4). *Pisidium* was the dominant pelecypod genus, comprising 98.2% of the pelecypod abundance or 5.5% of the benthos (Table 4).

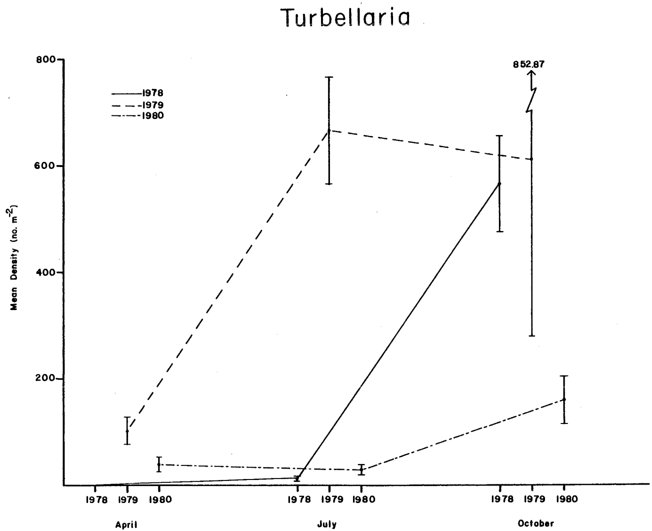

Fig. 20. Mean density (number m^{-2}) of turbellarians collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

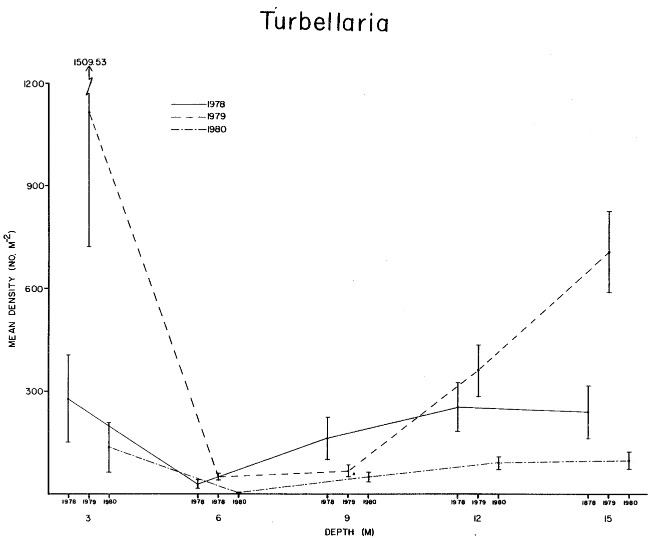

Fig. 21. Mean density (number m^{-2}) of turbellarians collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

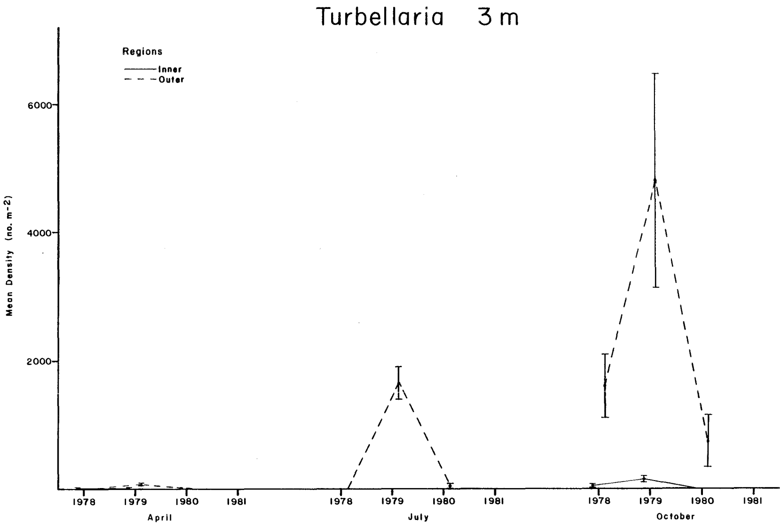

Fig. 22. Inner and outer regional mean densities (number m^{-2}) of turbellarians collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 3-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

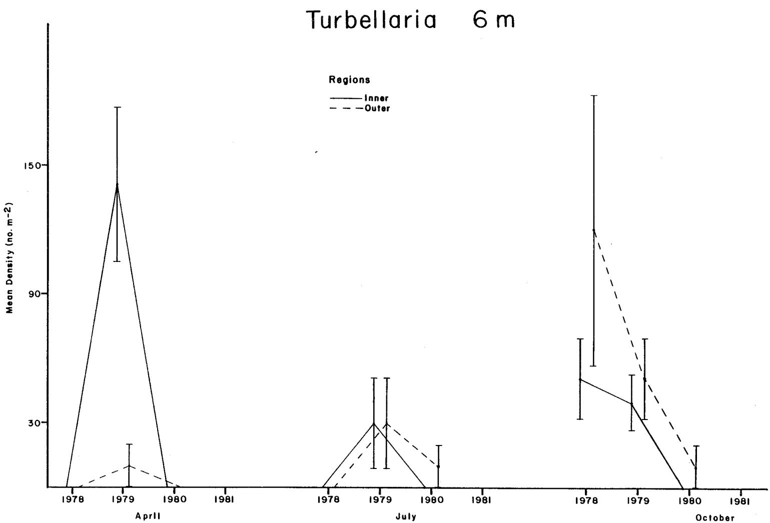

Fig. 22. Continued.

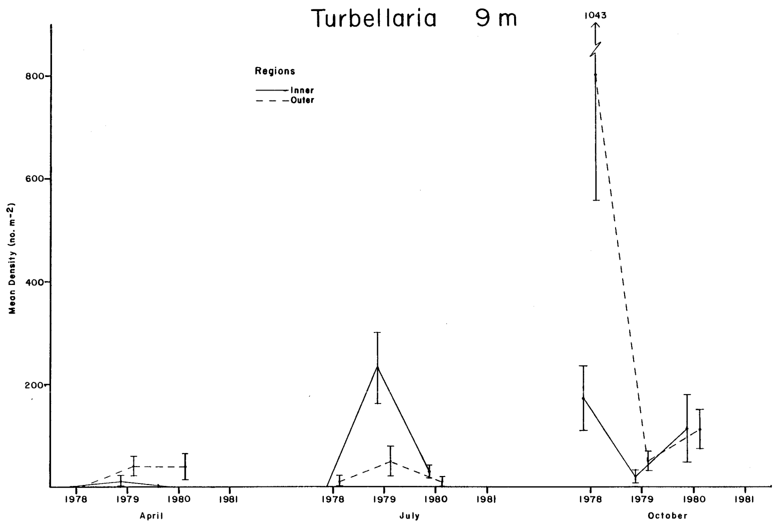

Fig. 22. Continued.

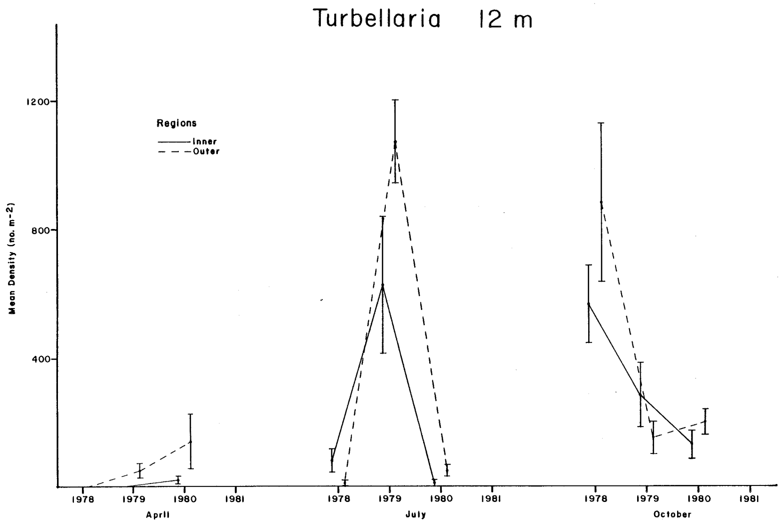

Fig. 22. Continued.

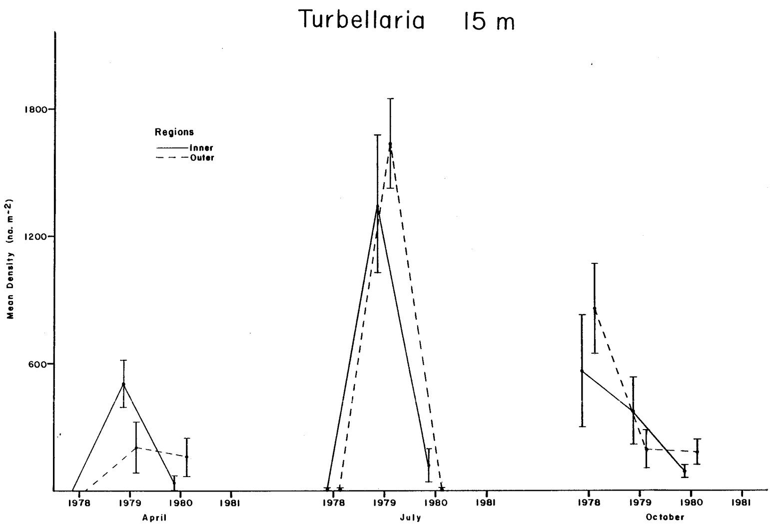

Fig. 22. Continued.

Pisidium

A shift in species dominance from P. nitidum nitidum in 1978 to P. casertanum in 1979 was more pronounced during 1980, although rank ordering of the five dominant pisidia was the same as that observed during 1979. Percent occurrence of P. n. nitidum continued to decrease from 1978 (31%) to 1980 (13%), and P. casertanum increased from 1978 (23%) to 1980 (42%). Percent occurrence of P. fallax, which increased from 1978 to 1979, did not change much from 1979 (19%) to 1980 (15%). The change in species dominance occurred similarly in both regions (Appendix 4).

Distributional patterns of Pisidium followed the same general patterns established during the previous 2 yr. Mean monthly pisidia abundance increased from April through October during 1980 (Fig. 23). Increased pisidia density from April to October was mostly due to annual reproduction, as October specimens were primarily small individuals. Average density of Pisidium at each depth in 1980 was most similar to that observed during 1978, but nonetheless increased with increasing depth during all 3 yr. Very few pisidia were observed at 3 and 6 m in any year (Fig. 24), likely due to coarser substrates and higher degree of turbulence and shifting sands not conducive to the filter feeding activity of clams.

Regional comparisons of mean Pisidium abundance indicated sporadic differences, although the general trend indicated densities were consistently less in the inner when compared with the outer region (Fig. 25). Since these discrepancies were minimal in either succeeding months or years at a given depth, and since regional species composition

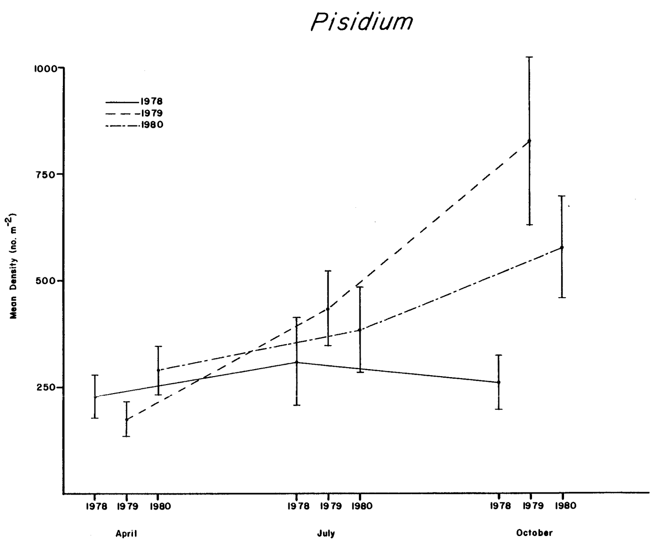

Fig. 23. Mean density (number m^{-2}) of Pisidium collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

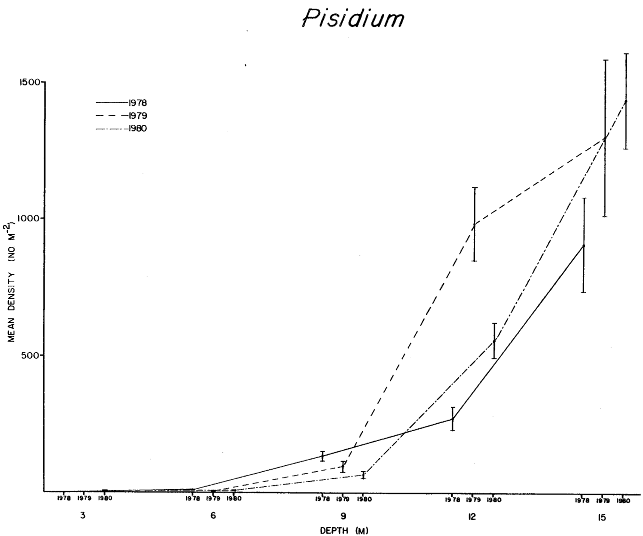

Fig. 24. Mean density (number m^{-2}) of Pisidium collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

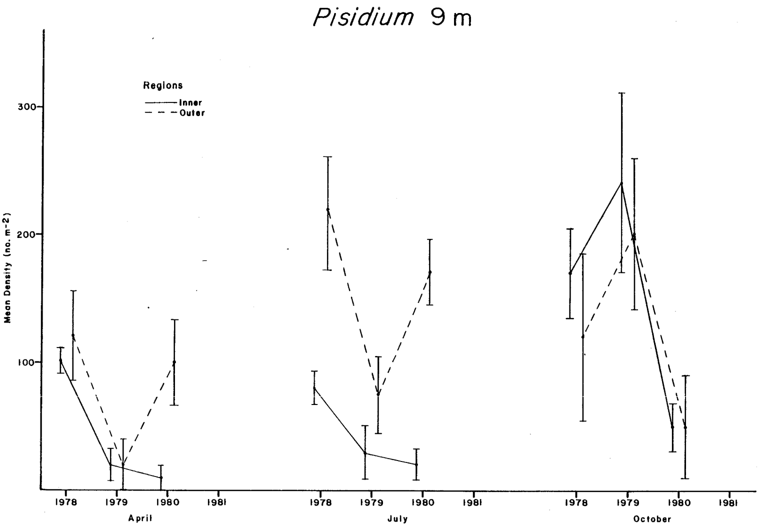

Fig. 25. Inner and outer regional mean densities (number m^{-2}) of Pisidium collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 9-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

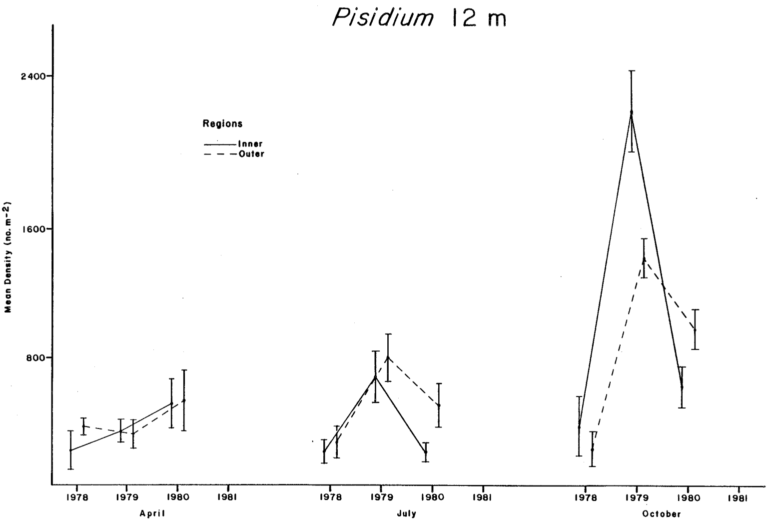

Fig. 25. Continued.

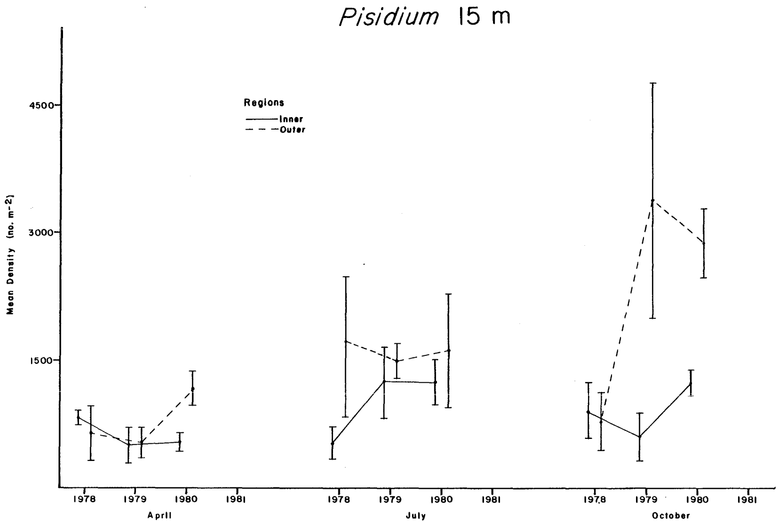

Fig. 25. Continued.

was very similar, little significance can be assigned to observed regional differences at this time.

Sphaerium and *Musculium*

The sphaeriid species *Musculium transversum*, previously assigned to the genus *Sphaerium*, has been reassigned to *Musculium* (Mackie et al. 1980). Consequently, there are now two genera where earlier reports listed only *Sphaerium*. *M. transversum* was observed only during 1979.

S. striatinum has continued to be the most abundant *Sphaerium* species in the survey area (6 m^{-2}). When all species of *Sphaerium* and *Musculium* were combined to represent sphaeriids exclusive of *Pisidium*, similar annual densities were observed from 1978 to 1980, with maximum yearly abundances occurring at 12 and 15 m (Fig. 26).

Sphaerium nitidum continued to be poorly represented at depths sampled during the survey years 1978 to 1980. Annual densities of *Sphaerium nitidum* have never exceeded 1.3 m^{-2}. Since 1978, *S. nitidum* density has decreased until in 1980 no specimens were collected (Appendix 4). However, it is likely that 12 to 15 m is the nearshore extent of a *S. nitidum* population which is more successful in deeper waters. During 1977 at 20 and 25 m, *S. nitidum* was observed in average densities of approximately 100 m^{-2}.

GASTROPODA

As during previous years, *Valvata sincera* was the most abundant of five gastropod taxa in the survey area during 1980 (Appendix 4). *Lymnaea* sp. continued to be the second-most numerous gastropod as was

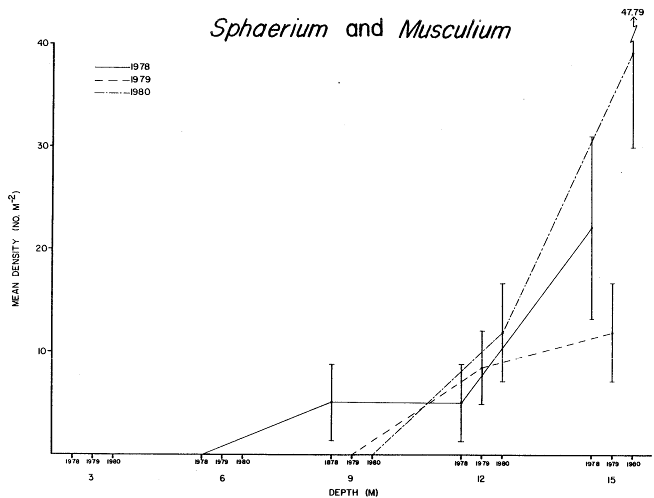

Fig. 26. Mean density (number m^{-2}) of Sphaerium and Musculium spp. collected from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

the case during 1979. Gastropods were again represented in one-third of the samples collected and had an annual mean density during 1980 (81 m^{-2}) similar to those found in previous years (Table 4).

Although average gastropod density at each depth in 1980 was similar to other years and followed the same distributional pattern (i.e., low numbers at depths less than 12 m and 150-250 m^{-2} at 12 and 15 m), mean monthly density varied (Figs. 27 and 28). Regardless of annual or monthly density fluctuations for gastropods, regional density trends were similar for nearly all depths within each month sampled (Fig. 29).

PONTOPOREIA HOYI

Annual mean abundance of chironomids (2224 m^{-2}) and oligochaetes (2213 m^{-2}) was greater than that of *P. hoyi* (1602 m^{-2}) during 1978. However, during subsequent years, *P. hoyi* was the dominant organism collected in both regions of the survey area, having an annual mean density of 2883 m^{-2} in 1979 and 2955 m^{-2} in 1980 (Tables 4 and 5). *P. hoyi* abundance in 1980 most closely approximated that of 1979, with monthly and depth distributional patterns resembling those of previous years, i.e., high densities in July following release of young in April and May, and with respect to depth, relatively few individuals at 3 and 6 m (Figs. 30 and 31).

An increasing annual density trend was observed from 1978 to 1980 in the inner region that was not observed concurrently in the outer region. Yearly average abundance of *P. hoyi* increased nearly two-fold in the inner region from 1978 (1852 m^{-2}) to 1980 (3642 m^{-2}). In addition, *P. hoyi* comprised 58% of the inner region benthic abundance in 1980 which compared with only 30% in 1978.

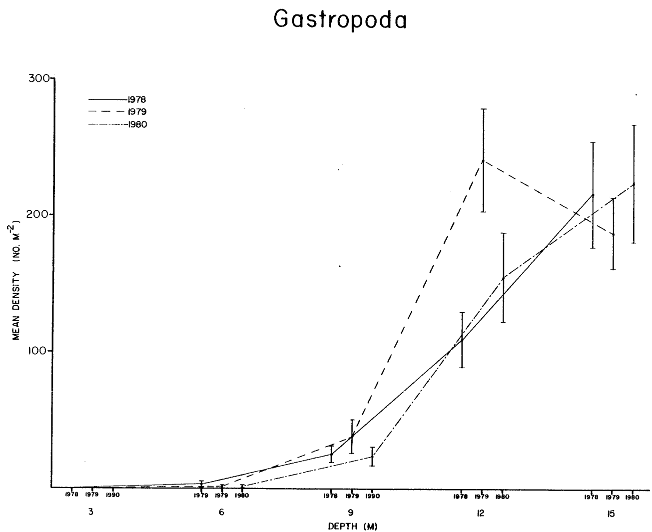

Fig. 27. Mean density (number m^{-2}) of gastropods collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

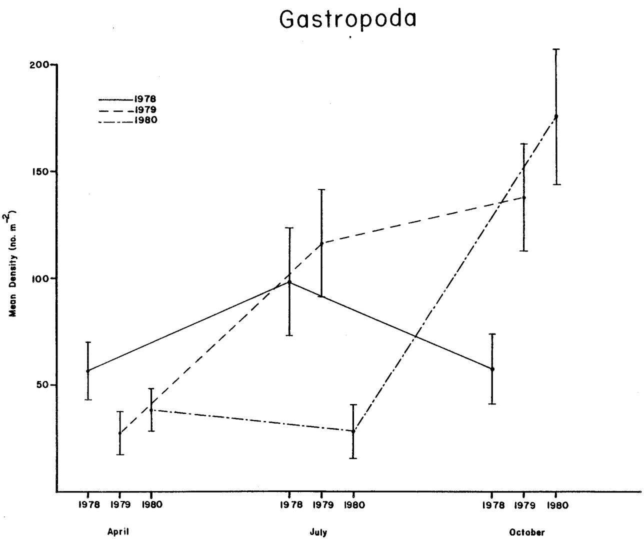

Fig. 28. Mean density (number m^{-2}) of gastropods collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

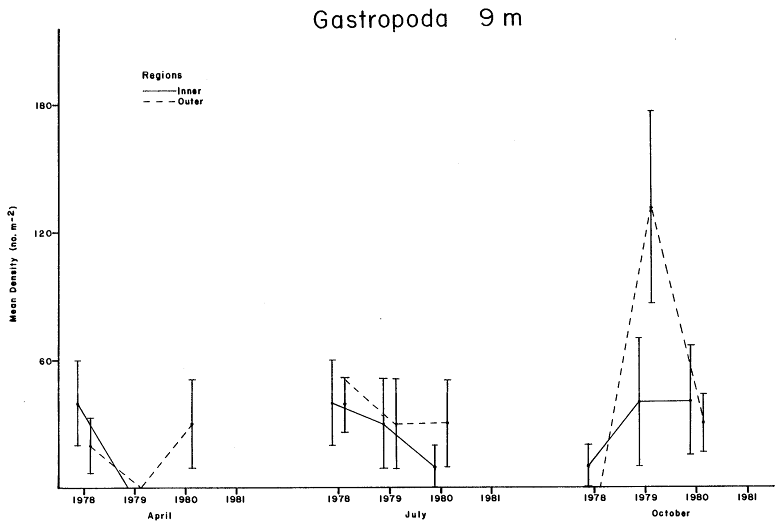

Fig. 29. Inner and outer regional mean densities (number m^{-2}) of gastropods collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 9-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar (n = 6). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

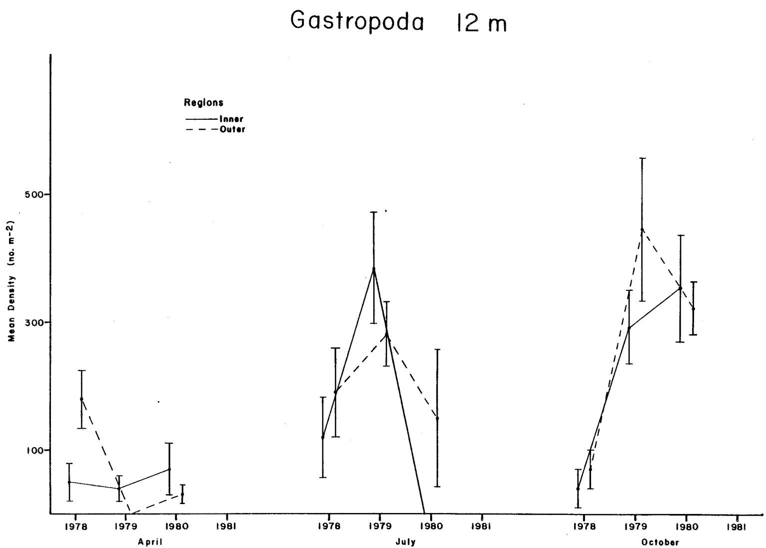

Fig. 29. Continued.

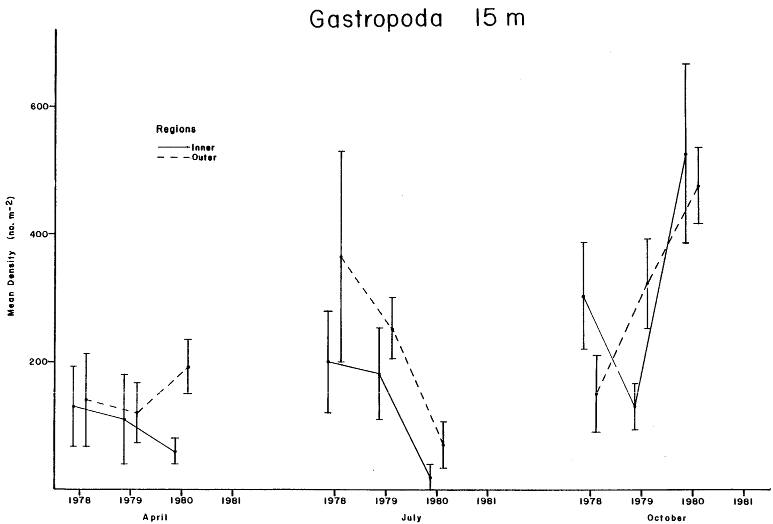

Fig. 29. Continued.

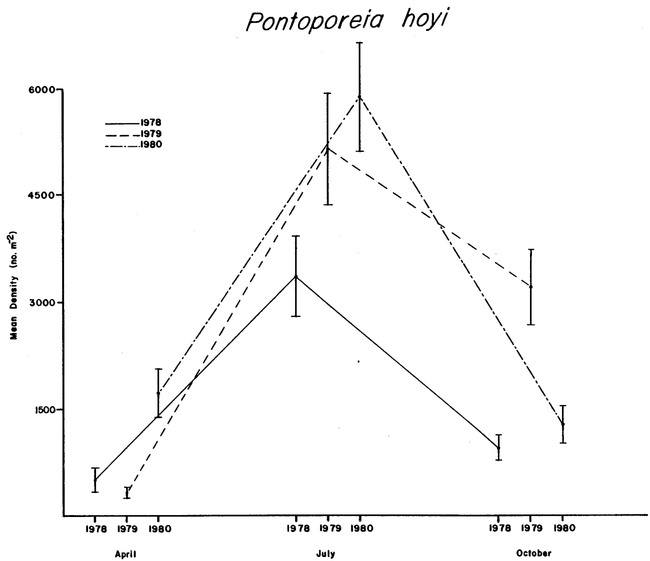

Fig. 30. Mean density (number m^{-2}) of P. hoyi collected during April, July, and October 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates for each month were computed by averaging over all depths within each year (n = 60). Standard error denoted by vertical bar.

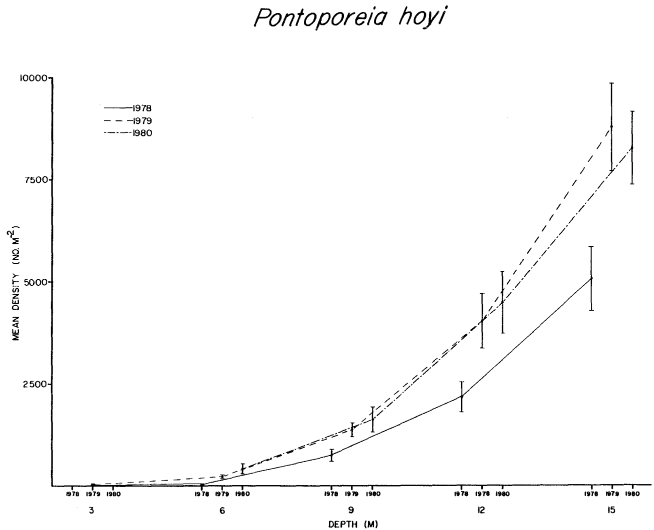

Fig. 31. Mean density (number m^{-2}) of P. hoyi collected at 3-15 m from 1978 through 1980 in eastern Lake Michigan near the J. H. Campbell Plant. Density estimates at each depth were computed by averaging over all months within each year (n = 36). Standard error denoted by vertical bar.

In the outer region, following a large increase in *P. hoyi* mean density from 1978 (1352 m^{-2}) to 1979 (2837 m^{-2}), there was a subsequent decrease in abundance during 1980 to 2267 m^{-2}. However, percent contribution of *P. hoyi* to the outer region benthic abundance remained at approximately 33% during the last 2 yr (Table 5). Consequently, while *P. hoyi* comprised an average 29% of the benthic community abundance in the outer region from 1978 through 1980, the inner region benthic community was comprised by 42% *P. hoyi*. The significance of this regional difference was largely that outer region *P. hoyi* percentage of the benthos was similar across years while that in the inner region increased with each successive year. Whether the percentage of *P. hoyi* in the inner region benthic community continues to rise is yet to be determined, but the inner region has consistently supported greater annual mean densities of *P. hoyi* when compared to the outer region. When averaged over all years the inner region *P. hoyi* average density was 2808 m^{-2} which compares with 2152 m^{-2} in the outer region.

Greatest differences between regions occurred during July at 9 and 12 m in 1980 (Fig. 32, Appendix 1). While a regional difference at 9 m in July was first noted in 1980, the difference at 12 m in July continued a trend first observed during 1979. In addition, at 15 m in July there was a reversal of the regional *P. hoyi* density trend during 1979, with the inner region *P. hoyi* density becoming greater than that of the outer region in 1980. However, in all examples regional differences in *P. hoyi* density were nearly non-existent in October samples.

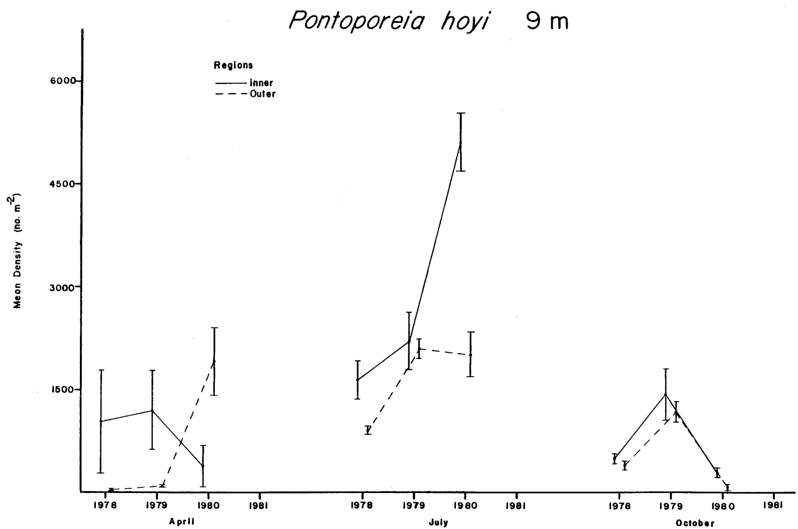

Fig. 32. Inner and outer regional mean densities (number m^{-2}) of P. hoyi collected in April, July, and October 1978 through 1980 from eastern Lake Michigan at 9-15 m near the J. H. Campbell Plant. Standard error denoted by vertical bar ($n = 6$). Inner region corresponds to treatment area near present thermal discharge. Outer region corresponds to reference area. Density estimates for 1981 will be added to figure as data become available.

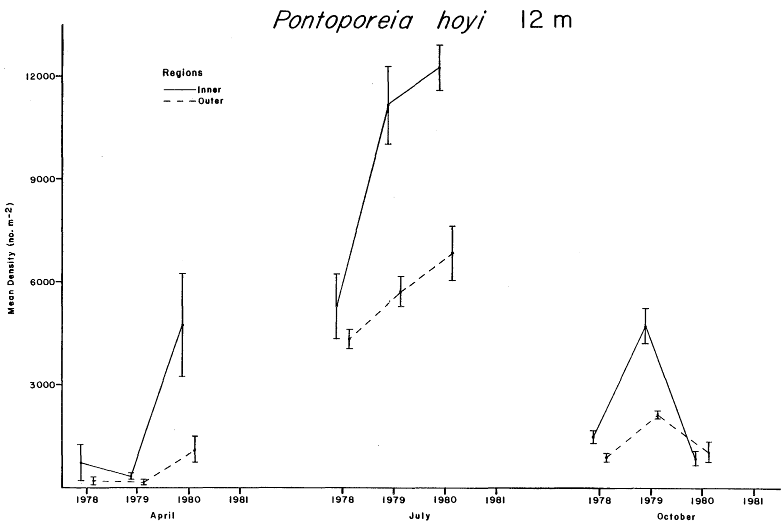

Fig. 32. Continued.

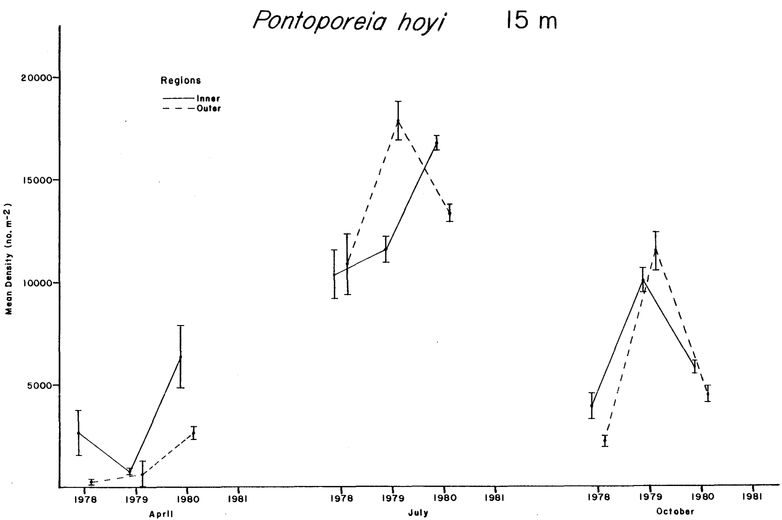

Fig. 32. Continued.

In 1978 and 1979, analysis of P. hoyi size classes indicated an apparent trend which was characterized by individuals of the inner region at 9 and 12 m in April and July being somewhat advanced, i.e., one size class larger (see key in Fig. 33 for size-class definition), than those of the outer region. In both years this difference was minimized by October (see Winnell and Jude 1979, 1980). A similar analysis in 1980 indicated very little regional difference in size class attained by P. hoyi at given depths for specific months (Fig. 33). Regional size-class differences were most evident in 1978, and although demonstrable in 1979, relative to 1978 they were less pronounced, and appeared to have become negligible during 1980.

There continued to be an onshore to offshore size-class trend associated with depth in the range 9 to 15 m. Most P. hoyi individuals collected at 9 and 12 m in April and July were one size class larger than those at 15 m. However, these differences were non-existent by October. This depth trend occurred in both regions.

SUBSTRATE DISTRIBUTION

Based on yearly mean percentage of sediment parameters, there has been virtually no difference in composition of the substrate from 1978 to 1980 (Table 6). The average substrate encountered in each year was well to moderately sorted fine sand, with 93% of substrate types lying in the medium to very fine sand range (1-4 units of phi).

Within each year, when comparing regional mean percentages of each sediment parameter at specific depths within months, some differences were noted. The greatest difference observed occurred during July 1979 in the inner region where a large increase in silt and clay substrates

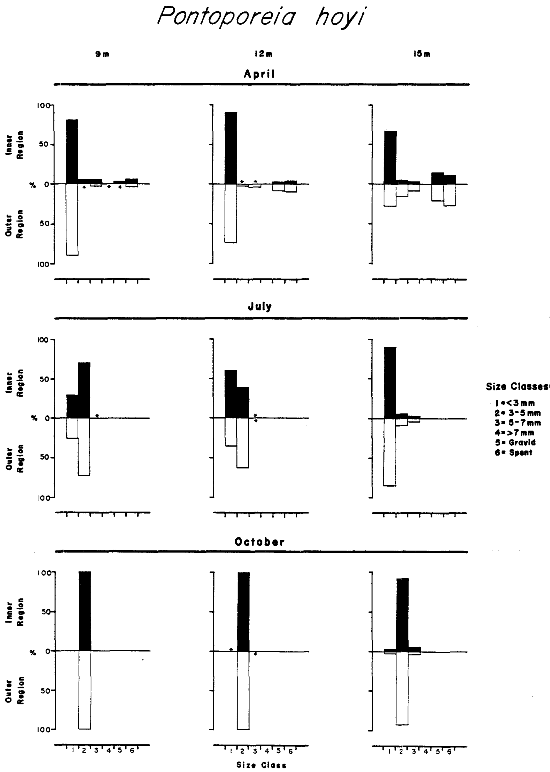

Fig. 33. Percent distribution of P. hoyi size classes in the inner and outer regions at 9-15 m during April, July, and October 1980. Samples were collected from eastern Lake Michigan near the J. H. Campbell Plant. (* = <2%).

Table 6. Annual average percent composition of substrates distributed among sediment grain sizes, mean grain sizes ($\bar{x}$), and average standard deviation of mean grain size (SD) (n=180 yr^{-1}) for sediments collected from 1978 to 1980 at 3-15 m near the J.H. Campbell Power Plant, eastern Lake Michigan.

Year	Sediment grain size (Phi units)										
	<-3	-3--2	-2--1	-1-0	0-1	1-2	2-3	3-4	≥ 4	$\bar{x}$	SD
1978	0.01	0.27	0.46	1.14	4.77	19.15	56.46	16.95	0.53	2.32	0.65
1979	0.03	0.07	0.26	0.70	3.40	14.86	58.73	19.86	2.09	2.47	0.60
1980	<0.01	0.03	0.25	1.32	4.49	23.75	57.61	12.19	0.37	2.24	0.63

was observed compared with previous sampling periods. As this regional substrate difference was negligible by October 1979, little regional difference was expected during 1980. Comparison of regional substrate trends during 1980 confirmed this view as few differences were present (Table 7). Most regional differences were minor percent fluctuations between medium- and fine-sand categories, although during July the inner region did have nearly twice the percentage (averaging 13.2%) of very fine sand (3-4 phi), than the outer region (6.7%). Again in October at 3 m there was a considerable regional difference, with the inner region comprised of a finer substrate (mean phi = 2.89) than the outer region (mean phi = 1.89). However, since medium to very fine sands were the predominant substrates expected to be encountered in the survey area in proportions that may be temporally and spatially variable, there was little reason to regard regional differences observed during 1980 with the significance of that ascribed to July 1979. Consequently, regional substrate types during 1980 were not thought to represent any definitive deviant trends from the expected sediment distribution patterns characteristic of previous years.

SUMMARY AND PROJECTED ANALYTICAL AND INTERPRETIVE PROBLEMS IN 1981

One purpose of this 4-yr study is to assess the effect of heated waste water (discharged from cooling processes in the Campbell Plant) on the macrobenthic community. At this juncture in data collection and analysis, two problems will complicate evaluation of thermal impact. The first problem is directly related to the conceptual design of the

TABLE 7. Average percent composition of sediments distributed among sediment grain sizes, average mean grain size ($\bar{x}$), and average standard deviation of mean grain size (SD) for sediments collected in 1980 at 3 to 15 m in the inner (treatment) and outer (reference) regions (n = 6) near the J. H. Campbell Plant, eastern Lake Michigan.

	April									
	3 m		6 m		9 m		12 m		15 m	
Sediment grain sizes (Phi units)	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region
<-3	0	0	0	0	0	0	0	0	0	0
-3--2	0.17	0	0	0	0	<0.01	0	0	0.02	0.01
-2--1	0.30	0	0.03	0.07	0.04	0.04	0.02	0.02	0.11	0.17
-1-0	0.69	0.03	0.01	0.64	0.29	0.09	0.11	0.03	0.42	0.21
0-1	4.81	1.10	1.94	11.08	2.32	0.56	0.68	0.29	1.79	1.52
1-2	64.35	66.67	42.80	12.10	10.68	2.10	7.03	5.28	15.42	16.83
2-3	28.40	31.80	52.75	73.17	81.93	91.05	80.03	85.57	59.98	57.47
3-4	1.27	0.34	2.31	2.90	4.70	6.08	12.02	8.73	21.98	23.60
≥ 4	0.06	0.04	0.04	0.04	0.04	0.05	0.11	0.09	0.30	0.20
$\bar{x}$	1.73	1.81	2.05	2.16	2.38	2.52	2.53	2.53	2.51	2.52
SD	0.59	0.49	0.56	0.61	0.49	0.32	0.48	0.38	0.70	0.72

	July									
	3 m		6 m		9 m		12 m		15 m	
Sediment grain sizes (Phi units)	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region
<-3	0	0	0	0	0	0	0	0	0	<0.01
-3--2	0	0	<0.01	0.14	0.01	0	0	0.01	0.03	0
-2--1	0.12	0.02	0.95	0.49	0.04	1.14	0.69	0.41	0.14	0.02
-1-0	3.22	1.63	2.26	7.91	1.41	2.99	2.36	3.36	2.10	3.56
0-1	10.54	4.44	5.01	14.28	5.72	8.90	9.31	12.97	9.09	8.18
1-2	34.45	39.73	25.48	33.58	23.54	34.95	37.07	25.43	26.15	31.88
2-3	38.05	48.38	55.65	39.03	54.28	45.45	41.58	49.75	44.02	47.28
3-4	13.41	5.69	10.43	4.39	14.88	6.37	8.83	7.94	18.37	8.89
≥ 4	0.29	0.11	0.21	0.20	0.12	0.23	0.18	0.21	0.11	0.22
$\bar{x}$	1.98	2.02	2.14	1.66	2.25	1.90	1.94	1.95	2.17	2.00
SD	0.85	0.70	0.78	0.85	0.66	0.83	0.79	0.85	0.84	0.74

	October									
	3 m		6 m		9 m		12 m		15 m	
Sediment grain sizes (Phi units)	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region	Inner Region	Outer Region
<-3	0	0	0	0	0	0	0	0	0	0
-3--2	0	0	0.56	0	0	0	<0.01	0	0	0.03
-2--1	0.02	0.01	2.38	0	<0.01	0.18	0.04	0.01	0.01	0.01
-1-0	0.02	0.02	5.74	0.03	0.05	0.03	0.10	0.03	0.08	0.08
0-1	0.07	1.84	11.27	2.05	0.94	0.09	0.93	0.38	1.29	1.33
1-2	4.44	57.18	20.75	7.13	11.42	0.78	9.36	9.79	20.45	15.72
2-3	46.23	40.68	51.38	84.92	75.95	92.28	63.47	60.62	60.10	47.03
3-4	43.03	0.27	7.07	5.76	11.39	6.64	25.55	29.02	17.87	35.38
≥ 4	6.17	0.01	0.16	0.10	0.26	0.15	0.52	0.18	0.26	0.40
$\bar{x}$	2.89	1.89	1.85	2.44	2.48	2.56	2.64	2.68	2.45	2.67
SD	0.55	0.50	0.73	0.44	0.47	0.28	0.62	0.61	0.65	0.74

survey's analytical methodology. Winnell and Jude (1980) defined the application of Johnston's (1973, 1974) mixed-model, nested analysis of variance (ANOVA) design to the present data for estimation of heat effect and precision of detection. The ANOVA was established as a balanced design with five essential factors; construction time (before and after offshore thermal discharge), year (nested within construction time), month, depth, and region [treatment (inner) and reference (outer)]. However, the offshore thermal discharge of Unit 3 did not commence until September 1980, instead of prior to April 1980 as had been anticipated. Consequently, the balanced design was altered to an unbalanced design with 3 yr of preoperational data (1978 through 1980) and 1 yr of operational data (1981) from the previous assumption of 2 preoperational (1978 and 1979) and 2 operational (1980 and 1981) years. Therefore, it will be necessary to evaluate the practicability and propriety of the resultant unbalanced design's application to assessment of heat effect. Given the conceptual change in the design, other models will be considered that may be more applicable.

A second problem that may limit or at least influence interpretation of significant interactions of construction time and region (heat effect) is the presence of preoperational regional differences for certain components of the benthic community. Analysis of 3 yr of annual mean density data gathered from 1978 to 1980 strongly suggests that _P. hoyi_ is becoming steadily more numerous and is comprising increasingly greater proportions of the benthos in the inner region when compared with the outer region. Several other major taxonomic groups, e.g., most oligochaetes, turbellarians, and chironomids, are somewhat more numerous in the outer region when

compared with the inner region, although the size of these differences was not as large as those noted for P. hoyi. Several of the benthic community components, i.e., tubificids, S. heringianus, and Pisidium, had consistent regional density differences during the last 2 yr at 15 m in October. Although recruitment from reproductive activity produce a large proportion of individuals encountered during October, whether regional differences were coincidental or causative remains undetermined. As these general trends appeared to be operating in the survey area, specific levels of comparison, (i.e., regional comparisons at each depth within each month sampled) are quite variable, with large density differences characteristic of 1 mo minimized in ensuing months and/or years. Annual abundance differences between regions for some taxa may or may not be adequately expressed in specific regional comparisons. Therefore, until the ANOVA is completed, no conclusive statements can be made regarding the significance of trends. However, presence of regional trends in preoperational data will require careful evaluation of ANOVA results.

Sedimentary trends observed in the 3-yr period from 1978 through 1980 generally lack annual distinctions. Substrates at 3-15 m were well to moderately sorted fine sand, with over 90% of the substrates being medium to very fine sand. While there was an expected depth-dependent distribution of sediments, overall trends have failed to indicate any regional differences in substrates, excepting the unusually high amounts of silt and clay observed in the inner region during July 1979 construction activity.

LITERATURE CITED

Alley, W.P. 1968. Ecology of the burrowing amphipod Pontoporeia affinis in Lake Michigan. Spec. Rep. No. 36. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 131 pp.

Alley, W.P. and S.C. Mozley. 1975. Seasonal abundance and spatial distributions of Lake Michigan macrobenthos, 1964-67. Spec. Rep. No. 54. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 103 pp.

Beck, E.C. and W.M. Beck, Jr. 1969. Chironomidae (Diptera) of Florida III. The Harnischia complex (Chironomidae). Bull. Florida State Mus. (Biol. Sci.) 13:277-313.

Coakley, J.P. and G.S. Beal. 1972. SEDAN - A computer program for sediment particle size analysis. Rep. Ser. No. 20, Canada Inland Water Directorate, Dept. Environ. 33 pp.

Consumers Power Company. 1975. J.H. Campbell Plant Unit No.3. Environ. Rep. Vol. 1. Consumers Power Co. Jackson, Mich. (Unnum. pp.)

Curry, L.L. 1958. Larvae and pupae of the species Cryptochironomus (Diptera) in Michigan. Limnol. Oceanogr. 3:77-95.

Hiltunen, J.K. 1967. Some oligochaetes from Lake Michigan. Trans. Amer. Microsc. Soc. 86:433-454.

_____ and D.J. Klemm. 1980. A guide to the Naididae (Annelida: Clitellata: Oligochaeta) of North America. Environ. Monit. Support Lab., Off. Res. Dev., USEPA, Cincinnati, Ohio. EPA-600/4-80-031. 48 pp.

Hirvenoja, M. 1973. Revision der Gattung Cricotopus van der Wulp und ihrer Verwandten (Diptera, Chironomidae). Ann. Zool. Fennici 10:1-363.

Jackson, G.A. 1977. Nearctic and palaearctic Paracladopelma Harnisch and Saetheria n. gen. (Diptera, Chironomidae). J. Fish. Res. Board Can. 34:1321-1359.

Johnston, E.M. 1973. Effect of a thermal discharge on benthos populations: statistical methods for assessing the impact of the Cook Nuclear Plant. Benton Harbor Power Plant Limnological Studies, Part XVIII. Spec. Rep. 44. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 20 pp.

_____. 1974. Statistical power of a proposed method for detecting the effect of waste heat on benthos populations. Benton Harbor Power Plant Limnological Studies, Part XX. Spec. Rep. No. 44. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 29 pp.

Jude, D.J., B.A. Bachen, G.R. Heufelder, H.T. Tin, M.H. Winnell, F.J. Tesar, and J.A. Dorr III. 1978. Adult and juvenile fish, ichthyoplankton and benthos populations in the vicinity of the J.H. Campbell Power Plant, eastern Lake Michigan, 1977. Spec. Rep. No. 65. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 639 pp.

Jude, D.J., G.R. Heufelder, H.T. Tin, N.A. Auer, S.A. Klinger, P.J. Schneeberger, T.L. Rutecki, C.P. Madenjian, and P.J. Rago. 1979. Adult and juvenile fish and ichthyoplankton in the vicinity of the J.H. Campbell Power Plant, eastern Lake Michigan, 1978. Spec. Rep. No. 73. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 607 pp.

Jude, D.J., G.R. Heufelder, N.A. Auer, H.T. Tin, S.A. Klinger, P.J. Schneeberger, C.P. Madenjian, T.L. Rutecki, and G.G. Godun. 1980. Adult and juvenile fish and ichthyoplankton in the vicinity of the J.H. Campbell Plant, eastern Lake Michigan, 1979. Spec. Rep. No. 79. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 607 pp.

Jude, D.J., H.T. Tin, G.R. Heufelder, P.J. Schneeberger, C.P. Madenjian, T.L. Rutecki, P.J. Mansfield, N.A. Auer, and G.E. Noguchi. 1981. Adult and juvenile fish and ichthyoplankton in the vicinity of the J.H. Campbell Power Plant, eastern Lake Michigan, 1977-1980. Spec. Rep. No. 86. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 425 pp.

Krumbein, W.C. 1938. Size frequency distribution of sediments and the normal phi curve. J. Sediment. Petrol. 8:84-90.

Lenz, F. 1954. Die Metamorphose der Tendipedinae (13c. B.). In E. Lindner, ed., Die Fliegen der palaearktischen Region, Vol. 3, pp. 139-169.

Mackie, G.L., D.S. White, and T.W. Zdeba. 1980. A guide to freshwater mollusks of the Laurentian Great Lakes with special emphasis on the genus *Pisidium*. Environ. Res. Lab., Large Lakes Res. Station, USEPA, Duluth, Minn. EPA-600/3-80-068. 144 pp.

Maschwitz, D.E. 1975. Revision of the nearctic species of the subgenus *Polypedilum* (Chironomidae: Diptera). Ph.D. Thesis. Univ. Minn., Minneapolis, Minn. 325 pp.

Mozley, S.C. 1974. Preoperational distribution of benthic macroinvertebrates in Lake Michigan near the Cook Nuclear Power Plant. In Seibel, E. and J.C. Ayers, eds. The biological, chemical, and physical character of Lake Michigan in the vicinity of the Donald C. Cook Nuclear Plant, pp. 5-138. Spec. Rep. No. 51. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich.

_____. 1975. Preoperational investigations of zoobenthos in southeastern Lake Michigan near the Cook Nuclear Plant. Spec. Rep. No. 56. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 132 pp.

_____ and W.P. Alley. 1973. Distribution of benthic invertebrates in the south end of Lake Michigan. In Proc. 16th Conf. Great Lakes Res., pp. 87-96. Internat. Assoc. Great Lakes Res.

_____ and O. Chapelsky. 1973. A ponar grab modified to take three samples in one cast with notes on ponar construction. In Proc. 16th Conf. Great Lakes Res., pp. 97-99. Internat. Assoc. Great Lakes Res.

_____ and L.C. Garcia. 1972. Benthic macrofauna in the coastal zone of southeastern Lake Michigan. In Proc. 15th Conf. Great Lakes Res., pp. 102-116. Internat. Assoc. Great Lakes Res.

_____ and R.P. Howmiller. 1977. Environmental status of the Lake Michigan region, Vol. 6, Benthos of Lake Michigan. Argonne Nat. Lab. ANL/ES-40. Argonne, Ill. 48 pp.

_____ and M.H. Winnell. 1975. Macrozoobenthic species assemblages of southeastern Lake Michigan, U.S.A. Verh. Internat. Verein. Limnol. 19: 922-931.

Powers, C.F. and A. Robertson. 1965. Some quantitative aspects of the macrobenthos of Lake Michigan. In Proc. 8th Conf. Great Lakes Res., pp. 153-157. Great Lakes Res. Div. Publ. 13. Univ. Mich., Ann Arbor, Mich.

Roback, S.S. 1957. The immature tendipedids of the Philadelphia area (Diptera: Tendipedidae). Monogr. Acad. Nat. Sci. Philadelphia 9. 152 pp.

Robertson, A. and W.P. Alley. 1966. A comparative study of Lake Michigan macrobenthos. Limnol. Oceanogr. 11: 576-583.

Saether, O.A. 1969. Some nearctic Podonominae, Diamesinae, and Orthocladiinae (Diptera: Chironomidae). Bull. Fish. Res. Board Can. 170. 154 pp.

_____. 1971. Nomenclature and phylogeny of the genus Harnischia (Diptera: Chironomidae). Can. Ent. 103: 347-362.

_____. 1973. Taxonomy and ecology of three new species of Monodiamesa Kieffer, with keys to nearctic and palaearctic species of the genus (Diptera: Chironomidae). J. Fish. Res. Board Can. 30:665-679.

_____. 1975. Nearctic and palaearctic Heterotrissocladius (Diptera: Chironomidae). Bull. Fish. Res. Board Can. 193. 67 pp.

_____. 1976. Revision of Hydrobaenus, Trissocladius, Zalutschia, Paratrissocladius, and some related genera (Diptera: Chironomidae). Bull. Fish. Res. Board Can. 195. 287 pp.

_____. 1977. Taxonomic studies on Chironomidae: Nanocladius, Pseudochironomus, and the Harnischia complex. Bull. Fish. Res. Board Can. 196. 143 pp.

Seibel, E., R. Jensen, and C. Carlson. 1974. Surficial sediment distribution of the nearshore waters in southeastern Lake Michigan. In Seibel, E. and J.C. Ayers, eds., The biological, chemical, and physical character of Lake Michigan in the vicinity of the Donald C. Cook Nuclear Plant, pp. 369-432. Spec. Rep. No. 51. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich.

Soponis, A.R. 1977. A revision of the nearctic species of Orthocladius (Orthocladius) van der Wulp (Diptera: Chironomidae). Ent. Soc. of Canada, Ottawa. 187 pp.

Truchan, J.G. 1970. Biological survey of Lake Michigan in the vicinity of the Consumers Power Company's thermal discharge, August 11-13, 1970. (Unpub. ms.) Rep. of Mich. Dept. Nat. Res., Lansing, Mich. 16 pp.

Upchurch, S.B. 1969. Computer program for sediment textural analysis. U.S. Lake Survey Misc. Paper 69-3, Dept. Army, Lake Surv. District, Corps of Engineers. 27 pp.

Winnell, M.H. and D.J. Jude. 1979. Spatial and temporal distribution of benthic macroinvertebrates and sediments collected in the vicinity of the J.H. Campbell Plant, eastern Lake Michigan, 1978. Spec. Rep. No. 75. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 199 pp.

Winnell, M.H. and D.J. Jude. 1980. Spatial and temporal distribution of benthic macroinvertebrates and sediments collected in the vicinity of the J.H. Campbell Plant, eastern Lake Michigan, 1979. Spec. Rep. No. 77. Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich. 132 pp.

APPENDIX 1. Mean densities (number m^{-2}) of P. hoyi, miscellaneous taxa, and total benthos collected during April, July, and October 1980 in the inner (treatment) and outer (reference) regions at 3 to 15 m (n = 6) near the J. H. Campbell Plant, eastern Lake Michigan. In addition to mean ($\bar{X}$) and standard error (SE) parameters, size classes of P. hoyi and turbellarian species in each region have been expressed as percentages of total P. hoyi and total turbellarian, respectively.

Month: April

	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Pontoporeia hoyi										10.1	10.1		383.8	300.8		191.9	483.7	
P. hoyi <3 mm													313.1	277.4	81.6	1757.4	478.7	91.6
P. hoyi 3-5 mm													20.2	12.8	5.3	10.1	10.1	0.5
P. hoyi 5-7 mm										10.1	10.1	100.0	20.2	12.8	5.3	40.4	20.2	2.1
P. hoyi >7 mm																10.1	10.1	0.5
P. hoyi gravid													10.1	10.1	2.6	20.2	12.8	1.1
P. hoyi spent													20.2	20.2	5.3	80.8	25.5	4.2
Miscellaneous taxa				10.1	10.1		20.2	20.2		20.2	12.8		50.5	29.9		70.7	32.9	3.7
Total Turbellaria																40.4	25.5	2.1
Turbellarian sp. 1																		
Turbellarian sp. 2																40.4	25.5	100.0
Turbellarian sp. 3																		
Hydracarina													10.1	10.1				
Hydra sp.																		
Other Insecta				10.1	10.1		20.2	20.2		20.2	12.8		40.4	20.2		30.3	20.7	
Total Benthos	10.1	10.1		70.7	28.9		50.5	28.9		121.2	46.9		949.4	420.3		3575.4	639.7	

	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Pontoporeia hoyi	4736.9	1526.0		1121.1	361.8		6373.1	1517.0		2646.2	635.1		2298.8	645.4		1139.3	253.2	
P. hoyi <3 mm	4322.8	1461.6	91.3	828.2	308.5	73.9	4252.1	1145.5	66.7	737.3	367.8	27.9	1777.6	516.6	77.3	664.6	174.3	58.3
P. hoyi 3-5 mm	60.6	27.1	1.3	30.3	13.6	2.7	303.0	89.9	4.7	424.2	99.0	16.0	76.8	27.7	3.3	92.9	36.0	8.2
P. hoyi 5-7 mm	40.4	20.2	0.8	40.4	20.2	3.6	212.1	67.7	3.3	222.2	46.1	8.4	54.5	20.0	2.4	62.6	18.3	5.5
P. hoyi >7 mm																2.0	2.0	0.2
P. hoyi gravid	111.1	18.6	2.4	101.0	41.2	9.0	878.7	190.8	13.8	565.6	85.2	21.4	200.0	72.8	8.7	137.4	44.6	12.1
P. hoyi spent	202.0	69.4	4.3	121.2	49.5	10.8	727.2	202.2	11.4	696.9	199.6	26.3	189.9	65.4	8.3	179.8	61.7	15.8
Miscellaneous taxa	60.6	27.1	100.0	161.6	66.0		40.4	40.4		161.6	93.4		34.3	11.9		84.8	29.1	
Total Turbellaria	20.2	12.8		141.4	57.7		40.4	40.4		161.6	93.4		12.1	8.4		68.7	27.1	
Turbellarian sp. 1																		
Turbellarian sp. 2	20.2	12.8	100.0	141.4	83.8	100.0	40.4	40.4	100.0	161.6	93.4	100.0	12.1	8.4	100.0	68.7	27.1	100.0
Turbellarian sp. 3																		
Hydracarina													2.0	2.0				
Hydra sp.																		
Other Insecta	40.4	20.2		20.2	20.2								20.2	7.3		16.2	6.4	
Total Benthos	7251.8	1390.6		2969.4	917.3		8150.7	2074.0		7362.9	1679.2		3282.5	822.7		2819.9	623.9	

APPENDIX 1. Continued.

Month: July

Taxa	Depth: 3 m Inner region $\bar{X}$	SE	%	Depth: 3 m Outer region $\bar{X}$	SE	%	Depth: 6 m Inner region $\bar{X}$	SE	%	Depth: 6 m Outer region $\bar{X}$	SE	%	Depth: 9 m Inner region $\bar{X}$	SE	%	Depth: 9 m Outer region $\bar{X}$	SE	%
Total *Pontoporeia hoyi*	30.3	30.3		20.2	12.8		2009.9	70.3		454.5	119.9		5100.5	337.6		2020.0	326.2	
P. hoyi <3 mm	20.2	20.2	66.7				555.5	84.9	27.6	151.5	51.3	33.3	1555.4	162.4	30.5	535.3	122.6	26.5
P. hoyi 3-5 mm	10.1	10.1	33.3	20.2	12.8	100.0	1434.2	135.2	71.4	292.9	93.1	64.4	3524.9	318.9	69.1	1484.7	218.4	73.5
P. hoyi 5-7 mm							20.2	12.8	1.0	10.1	10.1	2.2	20.2	20.2	0.4			
P. hoyi >7 mm																		
P. hoyi gravid																		
P. hoyi spent																		
Miscellaneous taxa				50.5	50.5		20.2	20.2		10.1	10.1		40.4	20.2		60.6	15.6	
Total Turbellaria				50.5	50.5					10.1	10.1		30.3	13.6		10.1	10.1	
Turbellarian sp. 1																		
Turbellarian sp. 2				50.5	50.5	100.0				10.1	10.1	100.0	30.3		100.0	10.1	10.1	100.0
Turbellarian sp. 3																		
Hydracarina																50.5	18.6	
Hydra sp.							20.2	20.2					10.1	10.1				
Other Insecta																		
Total Benthos	6898.3	2169.2		15736.0	6424.2		5211.6	782.5		4595.5	1876.1		8181.0	643.4		7251.8	677.3	

Taxa	Depth: 12 m Inner region $\bar{X}$	SE	%	Depth: 12 m Outer region $\bar{X}$	SE	%	Depth: 15 m Inner region $\bar{X}$	SE	%	Depth: 15 m Outer region $\bar{X}$	SE	%	All depths combined Inner region $\bar{X}$	SE	%	All depths combined Outer region $\bar{X}$	SE	%
Total *Pontoporeia hoyi*	12261.0	664.7		6847.8	766.3		16705.0	375.1		13322.0	428.0		7221.5	1181.3		4532.9	949.1	
P. hoyi <3 mm	7494.2	556.2	61.1	2474.5	609.3	36.1	15009.0	403.7	89.8	11514.0	440.1	86.4	4926.8	1067.7	68.2	2935.1	825.6	64.8
P. hoyi 3-5 mm	4646.0	206.2	37.9	4322.8	279.3	63.1	1111.0	222.7	6.7	1171.6	183.6	8.8	2145.2	325.4	29.7	1458.4	294.3	32.2
P. hoyi 5-7 mm	121.2	38.3	1.0	50.5	24.3	0.7	585.8	61.9	3.5	636.3	122.0	4.8	149.5	43.7	2.1	139.4	51.7	3.1
P. hoyi >7 mm																		
P. hoyi gravid																		
P. hoyi spent																		
Miscellaneous taxa	10.1	10.1		50.5	18.6		121.2	78.2		10.1	10.1		38.4	17.5		36.4	11.5	
Total Turbellaria	10.1	10.1		50.5	18.6		121.2	78.2		10.1	10.1		32.3	17.8		26.3	11.1	
Turbellarian sp. 1																		
Turbellarian sp. 2	10.1	10.1	100.0	50.5	18.6	100.0	121.2	78.2	100.0	10.1	10.1	100.0	32.3	17.8	100.0	26.3	11.1	100.0
Turbellarian sp. 3																		
Hydracarina																10.1	5.1	
Hydra sp.													6.1	4.5				
Other Insecta																		
Total Benthos	15170.0	944.0		12635.0	1236.3		20705.0	897.3		18190.0	1673.0		11233.0	1194.0		11682.0	1527.0	

APPENDIX 1. Continued.

Month: October

Taxa	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total *Pontoporeia hoyi*	40.4	20.2					10.1	10.1	100.0				272.7	77.8	100.0	90.9	40.7	
P. hoyi <3 mm																		
P. hoyi 3-5 mm	40.4	20.2	100.0										272.7	77.8	100.0	90.9	40.7	100.0
P. hoyi 5-7 mm							10.1	10.1	100.0									
P. hoyi >7 mm																		
P. hoyi gravid																		
P. hoyi spent																		
Miscellaneous taxa	20.2	12.8		777.7	355.6					10.1	10.1		111.10	65.3		181.8	41.4	
Total Turbellaria				757.5	360.1					10.1	10.1		111.10	65.3		111.1	39.6	
Turbellarian sp. 1				757.5	360.1	100.0				10.1	10.1	100.0				10.1	10.1	9.1
Turbellarian sp. 2													90.9	46.3	81.8	101.0	30.0	90.9
Turbellarian sp. 3													20.2	20.2	18.2			
Hydracarina	20.2	12.8																
Hydra sp.				20.2	12.8											70.7	28.9	
Other Insecta																		
Total Benthos	909.0	285.1					1807.9	1650.8		838.3	208.4		4060.2	1136.2		8292.1	1056.1	

Taxa	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total *Pontoporeia hoyi*	898.9	152.8		1060.5	263.1		5807.5	357.3		4494.5	418.5		1405.9	419.5		1129.2	334.1	
P. hoyi <3 mm	10.1	10.1	1.1				171.7	48.0	3.0	111.1	42.6	2.5	36.4	15.8	2.6	22.2	11.4	2.0
P. hoyi 3-5 mm	888.8	154.6	98.9	1050.4	259.8	99.0	5332.8	312.2	91.8	4201.6	4115.5	93.5	1306.9	384.2	93.0	1068.6	313.5	94.6
P. hoyi 5-7 mm				10.1	10.1	1.0	303.0	56.4	5.2	181.8	31.3	4.0	62.6	24.7	4.5	38.4	14.7	3.4
P. hoyi >7 mm																		
P. hoyi gravid																		
P. hoyi spent																		
Miscellaneous taxa	131.3	36.4		202.0	43.3		101.0	33.8		191.9	63.4		72.7	18.2		272.7	83.6	
Total Turbellaria	131.3	36.4	100.0	202.0	43.3		90.9	34.1		181.8	64.5		66.7	18.5		252.5	84.2	
Turbellarian sp. 1																155.5	87.2	61.6
Turbellarian sp. 2	101.0	30.0	75.0	202.0	43.3	100.0	90.9	34.1	100.0	181.8	64.5	100.0	56.6	14.8	84.9	97.0	22.2	38.4
Turbellarian sp. 3	30.3	13.6	25.0										10.1	5.1	15.1			
Hydracarina							10.1	10.1					6.1	3.4				
Hydra sp.										10.1	10.1					20.2	7.9	
Other Insecta																		
Total Benthos	4625.8	815.6		6443.8	746.4		9847.5	703.9		15009.0	2219.6		4250.1	718.8		6619.5	1061.8	

APPENDIX 2. Mean densities (number m^{-2}) of chironomid taxa collected during April, July, and October 1980 in the inner (treatment) and outer (reference) regions at 3 to 15 m (n = 6) near the J. H. Campbell Plant, eastern Lake Michigan. In addition to mean ($\bar{X}$) and standard error (SE) parameters, chironomid taxa collected in each region have been expressed as a percentage of total chironomids.

Month: April

	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Chironomidae	60.6	10.1		20.2	20.2					40.4	20.2		454.5	138.9		767.6	82.3	
Chironomus spp.													30.3	20.7	6.7			
Chironomus anthracinus-gr.																		
Chironomus fluviatilis-gr.													80.8	25.5	17.8	30.3	20.7	3.9
Cladopelma sp.																		
Cryptochironomus sp. 1																		
Cryptochironomus sp. 2													10.1	10.1	2.2	40.4	20.2	5.3
Cryptochironomus sp. 3																10.1	10.1	1.3
Cryptochironomus cf. rolli										10.1	10.1	25.0	20.2	2.8	4.4	30.3	30.3	3.9
Dicrotendipes sp.																		
Glyptotendipes sp.																		
Paracladopelma cf. nereis																		
Paraclsdopelma cf. undine																		
Paracladopelms csmptolabis-gr.													30.3	13.5	6.7	303.0	60.6	39.5
Paracladopelma cf. winnelli																		
Polypedilum cf. scalaenum													20.2	20.2	4.4	20.2	12.8	2.6
Polypedilum cf. tuberculum										10.1	10.1	25.0						
Polypedilum sp. 2																		
Robackia cf. demeijerei																		
Saetheria cf. tylus				20.2	20.2	100.0				10.1	10.1	25.0	212.1	65.9	46.7	242.4	51.9	31.6
Cladotanytarsus sp.																		
Micropsectra sp.																		
Tanytarsus sp.																		
Cricotopus/Orthoclsdius sp.													30.3	13.6	6.7	50.5	24.3	6.6
Cricotopus (Cricotopus) sp.																10.1	10.1	1.3
Cricotopus (C.) tremulus-gr.																		
Heterotrissocladius cf. chsngi																		
Heterotrissoclsdius cf. oliveri																		
Hydrobaenus sp.	60.6	10.1	100.0							10.1	10.1	25.0	20.2	12.8	4.4			
Paracladius sp.																10.1	10.1	1.3
Psectrocladius cf. simulans																		
Monodiamesa cf. tuberculata																20.2	20.2	2.6
Potthastia cf. longimsnus																		
Procladius sp.																		
Other Chironomidae																		

APPENDIX 2. Continued.

Taxa	Month: April																	
	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%
Total Chironomidae	717.1	90.5		606.0	185.8		454.5	82.4		757.5	101.1		327.2	62.4		438.3	75.8	
Chironomus spp.													6.1	4.5	1.9			
Chironomus anthracinus-gr.																		
Chironomus fluviatilis-gr.	70.7	28.9	9.9	10.1	10.1	1.7	10.1	10.1	2.2				32.3	10.0	9.9	8.1	4.8	1.8
Cladopelma sp.																		
Cryptochironomus sp. 1																		
Cryptochironomus sp. 2	161.6	30.0	22.5										34.3	13.2	10.5	8.1	4.8	1.8
Cryptochironomus sp. 3																2.0	2.0	0.5
Cryptochironomus cf. *rolli*	40.4	30.0	5.6	20.2	12.8	3.3							12.1	6.8	3.7	12.1	6.8	2.8
Dictotendipes sp.																		
Glyptotendipes sp.																		
Paracladopelma cf. *nereis*																		
Paracladopelma cf. *undine*																		
Paracladopelma camptolabis-gr.	121.2	27.1	16.9	101.0	33.8	16.7	20.2	12.8	4.4	50.5	18.6	6.7	34.3	10.4	10.5	90.9	24.8	20.7
Paracladopelma cf. *winnelli*				10.1	10.1	1.7	10.1	10.1	2.2	30.3	13.6	4.0	2.0	2.0	0.6	8.1	3.8	1.8
Polypedilum cf. *scalaenum*	40.4	30.0	5.6				10.1	10.1	2.2	10.1	10.1	1.3	14.1	7.5	4.3	6.1	3.4	1.4
Polypedilum cf. *tuberculum*	20.2	12.8	2.8	10.1	10.1	1.7	101.0	43.3	22.2	212.1	60.1	28.0	24.2	11.1	7.4	46.5	19.2	10.6
Polypedilum sp. 2							10.1	10.1	2.2				2.0	2.0	0.6			
Robackia cf. *demeijerei*																		
Saetheria cf. *tylus*	222.2	30.0	31.0	414.1	175.9	68.3	121.2	41.4	26.7	212.1	51.3	28.0	111.1	23.8	34.0	179.8	45.3	41.0
Cladotanytarsus sp.																		
Micropsectra sp.																		
Tanytarsus sp.																		
Cricotopus/Orthocladius sp.	10.1	10.1	1.4	20.2	12.8	3.3	20.2	12.8	4.4	30.3	13.6	4.0	12.1	4.5	3.7	20.2	6.7	4.6
Cricotopus (Cricotopus) sp.																2.0	2.0	0.5
Cricotopus (C.) tremulus-gr.	10.1	10.1	1.4										2.0	2.0	0.6			
Heterotrissocladius cf. *changi*							30.3	13.6	6.7	10.1	10.1	1.3	6.1	3.4	1.9	2.0	2.0	0.5
Heterotrissocladius cf. *oliveri*																		
Hydrobaenus sp.	10.1	10.1	1.4	10.1	10.1	1.7	40.4	12.8	8.9	40.4	12.8	5.3	16.2	5.0	5.0	12.1	4.5	2.8
Paracladius sp.																2.0	2.0	0.5
Paectrocladius cf. *simulans*																		
Monodiamesa cf. *tuberculata*	10.1	10.1	1.4	10.1	10.1	1.7	80.8	43.3	17.8	161.6	30.0	21.3	18.2	10.1	5.6	38.4	13.5	8.8
Potthastia cf. *longimanus*																		
Procladius sp.																		
Other Chironomidae																		

APPENDIX 2. Continued.

Taxa	Month: July																	
	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Chironomidae	5817.6	1705.9		13887.0	5723.2		1262.5	206.1		2363.4	91.2		1151.4	15.5		1757.4	204.0	
Chironomus spp.	40.4	20.2	0.7	90.9	34.1	0.7	20.2	20.2	1.6	40.4	30.0	1.7	10.1	10.1	0.9	30.3	13.6	1.7
Chironomus anthracinus-gr.																		
Chironomus fluviatilis-gr.	20.2	12.8	0.3	151.5	64.0	1.1	212.1	77.8	16.8	383.8	94.7	16.2	161.6	33.8	14.0	595.9	107.7	33.9
Cladopelma sp.																		
Cryptochironomus sp. 1	60.6	41.4	1.0	131.3	32.9	0.9	50.5	18.6	4.0							10.1	10.1	0.6
Cryptochironomus sp. 2							40.4	20.2	3.2	70.7	28.9	3.0	10.1	10.1	0.9	60.6	27.1	3.4
Cryptochironomus sp. 3	40.4	25.5	0.7				20.2	12.8	1.6				10.1	10.1	0.9			
Cryptochironomus cf. *rolli*	595.9	90.5	10.2	171.7	57.3	1.2	111.1	10.1	8.8	50.5	24.3	2.1	30.3	13.5	2.6			
Dicrotendipes sp.	10.1	10.1	0.2															
Glyptotendipes sp.																		
Parscladopelma cf. *nereis*				20.2	20.2	0.1												
Parscladopelma cf. *undine*	333.3	155.5	5.7	434.3	232.8	3.1	101.0	37.2	8.0	767.6	125.8	32.5	70.7	48.0	6.1	101.0	43.3	5.7
Paracladopelma camptolabis-gr.	141.4	61.9	2.4	333.3	108.1	2.4	80.8	30.0	6.4	232.3	67.1	9.8	90.9	40.6	7.9	171.7	28.9	9.8
Parscladopelma cf. *winnelli*	10.1	10.1	0.2							20.2	20.2	0.9	30.3	20.7	2.6	30.3	13.6	1.7
Polypedilum cf. *scalsenum*							20.2	20.2	1.6	30.3	20.7	1.3	191.9	61.4	16.7	101.0	46.1	5.7
Polypedilum cf. *tuberculum*																		
Polypedilum sp. 2																		
Robackia cf. *demeijerei*	161.6	37.2	2.8	919.1	154.4	6.6	161.6	25.5	12.8	323.2	83.8	13.7	30.3	13.6	2.6	161.6	37.2	9.2
Saetheria cf. *tylus*	2514.9	267.3	43.2	1525.1	570.5	11.0	343.4	74.5	27.2	282.8	72.8	12.0	30.3	13.6	2.6	30.3	13.6	1.7
Cladotanytarsus sp.																20.2	20.2	1.1
Micropsectra sp.													30.3	20.7	2.4	10.1	10.1	0.6
Tanytarsus sp.				10.1	10.1	0.1							10.1	10.1	0.8			
Cricotopus/*Orthocladius* sp.	60.6	27.1	1.0	242.4	171.4	1.7				10.1	10.1	0.4	202.0	37.2	16.0	272.7	60.1	15.5
Cricotopus (*Cricotopus*) sp.																		
Cricotopus (*C.*) *tremulus*-gr.																		
Heterotrissocladius cf. *changi*							20.2	12.8	1.6				50.5	18.6	4.0	10.1	10.1	0.6
Heterotrissocladius cf. *oliveri*																		
Hydrobaenus sp.																		
Paracladius sp.																		
Psectrocladius cf. *simulans*	1828.1	1244.4	31.4	9837.4	5427.7	70.8	80.8	30.0	6.4	151.5	51.3	6.4	121.2	41.4	9.6	101.0	30.0	5.7
Monodiamesa cf. *tuberculata*				20.2	20.2	0.1							70.7	36.4	5.6	50.5	24.3	2.9
Potthastia cf. *longimanus*																		
Procladius sp.																		
Other Chironomidae																		

APPENDIX 2. Continued.

Taxa	Month: July																	
	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%	$\overline{X}$	SE	%
Total Chironomidae	626.2	79.3		666.6	49.5		575.7	135.3		484.8	202.8		1886.7	489.2		3831.9	1421.6	
Chironomus spp.				10.1	10.1	1.5	20.2	12.8	3.5	10.1	10.1	2.1	18.2	6.6	1.0	36.4	10.7	0.9
Chironomus anthracinus-gr.				10.1	10.1	1.5										2.0	2.0	0.1
Chironomus fluviatilis-gr.	101.0	33.8	16.1	181.8	54.2	27.3	111.1	99.5	19.3				121.2	27.9	6.4	262.6	49.3	6.9
Cladopelma sp.							10.1	10.1	1.8				2.0	2.0	0.1			
Cryptochironomus sp. 1													22.2	9.8	1.2	28.3	11.5	0.7
Cryptochironomus sp. 2	30.3	13.6	4.8	20.2	12.8	3.0				10.1	10.1	2.1	16.2	5.8	0.9	32.3	9.5	0.8
Cryptochironomus sp. 3													14.1	6.3	0.7			
Cryptochironomus cf. rolli	40.4	20.2	6.5				10.1	10.1	1.8				157.6	44.8	8.4	44.4	16.9	1.2
Dictotendipes sp.													2.0	2.0	0.1			
Glyptotendipes sp.																		
Paracladopelma cf. nereis																4.0	4.0	0.1
Paracladopelma cf. undine				20.2	12.8	3.0							101.0	38.5	5.4	264.6	74.2	6.9
Paracladopelma camptolabis-gr.	30.3	13.6	4.8	50.5	24.3	7.6							68.7	17.6	3.6	157.6	33.3	4.1
Paracladopelma cf. winnelli	20.2	12.8	3.2	10.1	10.1	1.5	20.2	20.2	3.5				16.2	6.4	0.9	12.1	5.3	0.3
Polypedilum cf. scalsenum	80.8	46.1	12.9	30.3	20.7	4.5	70.7	36.4	12.3	70.7	28.9	14.6	72.7	20.4	3.9	46.5	14.1	1.2
Polypedilum cf. tuberculum	20.2	12.8	3.2	20.2	20.2	3.0	181.8	56.4	31.6	252.5	103.1	52.1	40.4	17.0	2.1	54.5	35.4	1.4
Polypedilum sp. 2																		
Robackia cf. demeijerei	50.5	18.6	8.1	20.2	12.8	3.0				10.1	10.1	2.1	80.8	15.7	4.3	286.8	70.8	7.5
Saetheria cf. tylus	80.8	43.3	12.9										593.9	187.2	31.5	367.6	152.8	9.6
Cladotanytarsus sp.	10.1	10.1	1.6										2.0	2.0	0.1	4.0	4.0	0.1
Micropsectra sp.	10.1	10.1	1.6	60.6	27.1	9.1	40.4	40.4	7.0	20.2	12.8	4.2	16.2	9.2	0.9	18.2	7.2	0.5
Tanytarsus sp.													2.0	2.0	0.1	2.0	2.0	0.1
Cricotopus/Orthocladius sp.	40.4	20.2	6.5	60.6	38.3	9.1							60.6	16.7	3.2	117.2	40.8	3.1
Cricotopus (Cricotopus) sp.																		
Cricotopus (C.) tremulus-gr.																		
Heterotrissocladius cf. changi	10.1	10.1	1.6	60.6	41.4	9.1				10.1	10.1	2.1	16.2	5.8	0.9	16.2	9.2	0.4
Heterotrissocladius cf. oliveri																		
Hydrobaenus sp.																		
Paracladius sp.																		
Psectrocladius cf. simulans	40.4	25.5	3.5	10.1	10.1	1.5							414.1	266.1	21.9	2020.0	1242.1	52.7
Monodiamesa cf. tuberculata	60.6	22.1	5.3	70.7	28.9	10.6	90.9	55.9	15.8	101.0	25.5	20.8	44.4	14.8	2.4	48.5	11.4	1.3
Potthastia cf. longimanus				10.1	10.1	1.5										2.0	2.0	0.1
Procladius sp.				20.2	12.8	3.0	10.1	10.1	1.8				2.0	2.0	0.1	4.0	2.8	0.1
Other Chironomidae							10.1	10.1	1.8				2.0	2.0	0.1			

APPENDIX 2. Continued.

Taxa	Month: October																	
	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Chironomidae	838.3	285.3		1737.2	854.8		1797.8	1640.7		797.9	218.7		939.3	243.3		3625.9	463.5	
Chironomus spp.	10.1	10.1	1.2															
Chironomus anthracinus-gr.																		
Chironomus fluviatilis-gr.	282.8	126.8	33.7							80.8	46.1	10.1	262.6	89.4	28.0	454.5	168.3	12.5
Cladopelma sp.																		
Cryptochironomus sp. 1																		
Cryptochironomus sp. 2	30.3	20.7	3.6				20.2	20.2	1.1	10.1	10.1	1.3	40.4	20.2	4.3	90.9	34.1	2.5
Cryptochironomus sp. 3	20.2	12.8	2.4	30.3	20.7	1.7	20.2	12.8	1.1	20.2	12.8	2.5	10.1	10.1	1.1			
Cryptochironomus cf. rolli				50.5	28.9	2.9	40.4	20.2	2.2	40.4	20.2	5.1	20.2	12.8	2.2	30.3	13.6	0.8
Dicrotendipes sp.																		
Glyptotendipes sp.										10.1	10.1	1.3						
Paracladopelma cf. nereis																		
Paracladopelma cf. undine																		
Paracladopelma camptolabis-gr.	393.9	141.5	47.0	10.1	10.1	0.6	10.1	10.1	0.6	525.2	207.4	65.8	212.1	71.3	22.6	2363.4	367.3	65.2
Paracladopelma cf. winnelli													10.1	10.1	1.1	10.1	10.1	0.3
Polypedilum cf. scalaenum	20.2	12.8	2.4							10.1	10.1	1.3	131.3	42.6	14.0	101.0	33.8	2.8
Polypedilum cf. tuberculum																		
Polypedilum sp. 2																		
Robackia cf. demeijerei				50.5	24.3	2.9	10.1	10.1	0.6									
Saetheria cf. tylus	50.5	32.9	6.0	1585.7	822.2	91.3	1696.8	1636.4	94.4	70.7	28.9	8.9	101.0	37.2	10.8	232.3	72.4	6.4
Cladotanytarsus sp.				10.1	10.1	0.6				20.2	20.2	2.5	90.9	79.4	9.7	80.8	40.4	2.2
Micropsectra sp.																		
Tanytarsus sp.																		
Cricotopus/Orthocladius sp.										10.1	10.1	1.3	60.6	38.3	6.5	242.4	89.9	6.7
Cricotopus (Cricotopus) sp.																		
Cricotopus (C.) tremulus-gr.																		
Heterotriasocladius cf. changi																		
Heterotriasocladius cf. oliveri																		
Hydrobaenus sp.																		
Paracladius sp.																		
Psectrocladius cf. simulans	20.2	8.2	2.4															
Monodiamesa cf. tuberculata																20.2	12.8	0.6
Potthastia cf. longimanus																		
Procladius sp.																		
Other Chironomidae	10.1	4.1	1.2															

APPENDIX 2. Continued.

Month: October

Taxa	Depth: 12 m — Inner region X̄	SE	%	Outer region X̄	SE	%	Depth: 15 m — Inner region X̄	SE	%	Outer region X̄	SE	%	All depths combined — Inner region X̄	SE	%	Outer region X̄	SE	%
Total Chironomidae	626.2	40.4		585.8	53.4		444.4	118.8		383.8	63.8		929.2	325.1		1426.1	289.2	
Chironomus spp.							10.1	10.1	2.3				4.0	2.8	0.4			
Chironomus anthracinus-gr.																		
Chironomus fluviatilis-gr.	121.2	51.9	19.4	70.7	24.3	12.1	20.2	12.8	4.5				137.4	37.5	14.8	121.2	45.5	8.5
Cladopelma sp.										10.1	10.1	2.6				2.0	2.0	0.1
Cryptochironomus sp. 1																		
Cryptochironomus sp. 2	191.9	48.0	30.6	141.4	25.6	24.1							56.6	16.9	6.1	48.5	13.4	3.4
Cryptochironomus sp. 3													10.1	4.2	1.1	10.1	5.1	0.7
Cryptochironomus cf. rolli				10.1	10.1	1.7				10.1	10.1	2.6	12.1	5.3	1.3	28.3	8.1	2.0
Dicrotendipes sp.																		
Glyptotendipes sp.																2.0	2.0	0.1
Paracladopelma cf. nereis																		
Paracladopelma cf. undine							10.1	10.1	2.3				2.0	2.0	0.2			
Paracladopelma camptolabis-gr.	131.3	32.9	21.0	121.2	35.0	20.7	20.2	20.2	4.5	20.2	12.8	5.3	153.5	40.1	16.5	608.0	184.3	42.6
Paracladopelma cf. winnelli										10.1	10.1	2.6	2.0	2.0	0.2	4.0	2.8	0.3
Polypedilum cf. scalaenum	30.3	20.7	4.8	30.3	30.3	5.2							36.4	12.9	3.9	28.3	11.2	2.0
Polypedilum cf. tuberculum							50.5	28.9	11.4	50.5	18.6	13.2	10.1	6.6	1.1	10.1	5.1	0.7
Polypedilum sp. 2																		
Robackia cf. demeijerei													2.0	2.0	0.2	10.1	5.9	0.7
Saetheria cf. tylus	90.9	13.6	14.5	121.2	51.9	20.7	30.3	30.3	6.8	20.2	12.8	5.3	393.9	327.3	42.4	406.0	189.2	28.5
Cladotanytarsus sp.				10.1	10.1	1.7							18.2	16.2	2.0	24.2	10.3	1.7
Micropsectra sp.																		
Tanytarsus sp.																		
Cricotopus/Orthocladius sp.				10.1	10.1	1.7							12.1	8.4	1.3	52.5	24.4	3.7
Cricotopus (Cricotopus) sp.																		
Cricotopus (C.) tremulus-gr.																		
Heterotrissocladius cf. changi	40.4	25.6	6.5	60.6	27.1	10.3	252.5	65.3	56.8	202.0	40.4	52.6	58.6	22.4	6.3	52.5	17.1	3.7
Heterotrissocladius cf. oliveri										20.2	12.8	5.3				4.0	2.8	0.3
Hydrobaenus sp.																		
Paracladius sp.																		
Psectrocladius cf. simulans										10.1	10.1	2.6	4.0	2.8	0.4	2.0	2.0	0.1
Monodiamesa cf. tuberculata	20.2	12.8	3.2	10.1	10.1	1.7	50.5	28.9	11.4	30.3	20.7	7.9	14.1	6.9	1.5	12.1	5.3	0.8
Potthastia cf. longimanus																		
Procladius sp.																		
Other Chironomidae													2.0	2.0	0.2			

APPENDIX 3. Mean densities (number m^{-2}) of annelid taxa collected during April, July, and October 1980 in the inner (treatment) and outer (reference) regions at 3 to 15 m (n = 6) near the J. H. Campbell Plant, eastern Lake Michigan. In addition to mean ($\bar{X}$) and standard error (SE) parameters, naidid and tubificid taxa collected in each region have been expressed as a percentage of total naidids and total tubificids, respectively.

Month: April

Taxa	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Naididae				20.2	20.2		20.2	12.8		50.5	39.6		10.1	10.1		232.2	52.9	
Amphichaeta leydigii										20.2	12.8	40.0				70.7	32.9	30.4
Chaetogaster diaphanus																		
Nais communis																10.1	10.1	4.3
Nais elinguis				20.2	20.2	100.0				20.2	20.2	40.0						
Nais pardalis																10.1	10.1	4.3
Nais simplex							20.2	12.8	100.0									
Nais variabilis																		
Piguetiella michiganensis													10.1	10.1	100.0	90.9	25.9	39.1
Stylaria lacustris																		
Uncinais uncinata																		
Vejdovskyella intermedia										10.1	10.1	20.0				50.5	18.6	21.7
Total Tubificidae							10.1	10.1					40.4	20.2		383.8	121.9	
Immature w/o hair chaetae							10.1	10.1	100.0				30.3	20.7	75.0	313.1	93.1	81.6
Immature w/ hair chaetae																		
Limnodrilus angustipenis													10.1	10.1	25.0			
Limnodrilus hoffmeisteri																20.2	12.8	5.3
Limnodrulus profundicola																		
Limnodrulus spiralis																10.1	10.1	2.6
Peloscolex freyi																		
Potamothrix moldaviensis																40.4	25.6	10.5
Potamothrix vejdovskyi																		
Stylodrilus heringianus																		
Enchytraeidae																70.7	32.9	
Hirudinea																		

APPENDIX 3. Continued.

Month: April

Taxa	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Naididae	141.4	40.4		80.8	25.6		60.6	31.3		40.4	40.4		46.5	13.8		84.8	21.1	
Amphichaeta leydigii	20.2	20.2	14.3	20.2	20.2	25.0	10.1	10.1	16.7	20.2	20.2	50.0	6.1	4.5	13.1	26.3	9.5	31.0
Chaetogaster diaphanus																		
Nais communis				10.1	10.1	12.5										4.0	2.8	4.7
Nais elinguis																8.1	5.6	9.6
Nais pardalis				10.1	10.1	12.5										4.0	2.8	4.7
Nais simplex													4.0	2.8	8.6			
Nais variabilis							10.1	10.1	16.7				2.0	2.0	4.3			
Piguetiella michiganensis	121.2	35.0	85.7	40.4	20.2	50.0	30.3	13.5	50.0	20.2	20.2	50.0	32.3	11.2	69.5	30.3	9.5	35.7
Stylaria lacustris																		
Uncinais uncinata																		
Vejdovskyella intermedia							10.1	10.1	10.1				2.0	2.0	4.3	12.1	5.3	14.3
Total Tubificidae	979.7	205.5		191.9	72.4		525.2	321.3		1222.1	288.3		311.1	101.1		359.6	103.3	
Immature w/o hair chaetae	929.2	197.7	94.8	151.5	64.0	78.9	424.2	241.4	80.8	1040.3	207.2	85.1	278.8	88.9	89.6	301.0	84.2	83.7
Immature w/ hair chaetae							10.1	10.1	1.9				2.0	2.0	0.6			
Limnodrilus angustipenis	10.1	10.1	1.0										4.0	2.8	1.3			
Limnodrilus hoffmeisteri	10.1	10.1	1.0	10.1	10.1	5.3				10.1	10.1	0.8	2.0	2.0	0.6	8.1	3.8	2.3
Limnodrilus profundicola	20.2	12.8	2.1	10.1	10.1	5.3	10.1	10.1	1.9				6.1	3.4	2.0	2.0	2.0	0.6
Limnodrilus spiralis				20.2	20.2	10.5	10.1	10.1	1.9				2.0	2.0	0.6	6.1	4.5	1.7
Peloscolex freyi																		
Potamothrix moldaviensis	10.1	10.1	1.0				40.4	40.4	7.7	131.3	65.3	10.7	10.1	8.3	3.2	34.3	16.1	9.5
Potamothrix vejdovskyi							30.3	20.7	5.8	40.4	30.0	3.3	6.1	4.5	2.0	8.1	6.3	2.3
Stylodrilus heringianus							50.5	39.6		434.3	221.0		10.1	8.3		86.9	52.2	
Enchytraeidae	20.2	20.2		252.5	143.8		40.4	40.4		686.8	344.5		12.1	8.9		202.0	84.6	
Hirudinea										10.1	10.1					2.0	2.0	

APPENDIX 3. Continued.

Taxa	Month: July																	
	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Naididae	1050.4	490.5		1777.6	556.2		1676.6	777.5		1363.5	352.9		1565.5	465.3		2272.5	298.4	
Amphichaeta leydigii																		
Chaetogaster diaphanus	60.6	31.3	5.8	212.1	48.9	11.9	80.8	59.9	4.8	333.3	74.6	24.4	202.0	111.4	12.9	1050.4	242.2	46.2
Nais communis										10.1	10.1	0.7						
Nais elinguis	50.5	32.9	4.8	20.2	20.2	1.1												
Nais pardalis	20.2	12.8	1.9							30.3	20.7	2.2	10.1	10.1	0.6	20.2	12.8	0.9
Nais simplex							10.1	10.1	0.6									
Nais variabilis	767.6	387.6	73.1	1484.7	513.9	83.5	878.7	416.3	52.4	373.7	118.6	27.4	424.2	93.9	27.1	151.5	60.1	6.7
Piguetiella michiganensis							343.3	90.8	20.5	20.2	12.8	1.5	151.5	76.3	9.7	191.9	28.9	3.1
Stylaria lacustris	111.1	45.4	10.6	50.5	24.3	2.8	151.5	55.7	9.0	252.5	105.4	18.5	444.4	171.2	28.4	464.6	151.4	16.3
Uncinais uncinata	40.4	30.3	3.8	10.1	10.1	0.6	191.9	63.4	11.4	333.3	141.5	24.4	141.4	55.7	9.0	161.6	25.6	2.8
Vejdovskyella intermedia							20.2	12.8	1.2	10.1	10.1	0.7	191.9	50.5	12.3	232.3	65.3	7.0
Total Tubificidae							171.7	126.6		292.9	152.8		262.6	179.5		929.2	220.0	
Immature w/o hair chaetae							121.2	78.2	70.6	272.7	137.1	93.1	252.5	169.5	96.2	545.4	150.9	58.7
Immature w/ hair chaetae																		
Limnodrilus angustipenis							20.2	20.2	11.8							80.8	37.2	8.7
Limnodrilus hoffmeisteri																60.6	49.5	6.5
Limnodrulus profundicola							10.1	10.1	5.9	10.1	10.1	3.4						
Limnodrulus spiralis																		
Peloscolex freyi							20.2	20.2	11.8				10.1	10.1	3.8	161.6	55.7	17.4
Potamothrix moldaviensis										10.1	10.1	3.4				80.8	69.4	8.7
Potamothrix vejdovskyi																		
Stylodrilus heringianus													10.1	10.1				
Enchytraeidae							50.5	50.5		90.9	58.0		20.2	12.8		10.1	10.1	
Hirudinea																		

APPENDIX 3. Continued.

Month: July

Taxa	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Naididae	1090.8	343.5		2272.5	517.5		434.4	99.5		161.6	69.3		1163.5	199.2		1569.5	220.3	
Amphichaeta leydigii																		
Chaetogaster diaphanus	30.3	20.7	2.8	535.3	171.7	23.6	70.7	28.9	16.3	50.5	28.9	31.3	88.9	27.4	7.6	436.3	86.4	27.8
Nais communis																2.0	2.0	0.1
Nais elinguis							10.1	10.1	2.3				12.1	7.4	1.0	4.0	4.0	0.3
Nais pardalis				20.2	12.8	0.9	30.3	30.3	7.0	20.2	12.8	12.5	12.1	5.3	1.0	18.2	5.9	1.2
Nais simplex													2.0	2.0	0.2			
Nais variabilis	131.3	24.3	12.0				70.7	39.6	16.3				454.5	123.3	39.1	402.0	143.1	25.6
Piguetiella michiganensis	141.4	43.3	13.0	70.7	24.3	3.1	10.1	10.1	2.3				129.3	33.0	11.1	56.6	15.4	3.6
Stylaria lacustris	262.6	147.3	24.1	797.9	288.3	35.1	171.7	87.7	39.5	40.4	25.5	25.0	228.3	51.9	19.6	321.2	82.9	20.5
Uncinais uncinata	131.3	65.3	12.0	141.4	25.6	6.2	30.3	20.7	7.0	10.1	10.1	6.3	107.1	23.9	9.2	131.3	35.1	8.4
Vejdovskyella intermedia	393.9	178.9	36.1	707.0	223.8	31.1	40.4	20.2	9.3	40.4	20.2	25.0	129.3	44.4	11.1	198.0	66.1	12.6
Total Tubificidae	717.1	252.0		1858.4	119.8		838.3	241.1		1282.7	501.5		397.9	97.3		872.6	164.6	
Immature w/o hair chaetae	666.6	242.4	93.0	1494.8	114.6	80.4	535.3	142.9	63.9	666.6	187.1	52.0	315.1	78.0	79.2	595.9	109.0	68.3
Immature w/ hair chaetae							10.1	10.1	1.2	10.1	10.1	0.8	2.0	2.0	0.5	2.0	2.0	0.2
Limnodrilus angustipenis	10.1	10.1	1.4	90.9	46.3	4.9	40.4	25.6	4.8				14.1	6.9	3.5	34.3	13.5	3.9
Limnodrilus hoffmeisteri				141.4	37.2	7.6	121.2	60.6	14.5	141.4	61.9	11.0	24.2	14.4	6.1	68.7	20.1	7.9
Limnodrilus profundicola	20.2	12.8	2.8	20.2	12.8	1.1	10.1	10.1	1.2	10.1	10.1	0.8	8.1	3.8	2.0	8.1	3.8	0.9
Limnodrilus spiralis																		
Peloscolex freyi	20.2	20.2	2.8	50.5	18.6	2.7							10.1	5.9	2.5	42.4	16.0	4.9
Potamothrix moldaviensis				50.5	28.9	2.7	111.1	55.1	13.3	414.1	283.1	32.3	22.2	13.1	5.6	111.1	61.5	12.7
Potamothrix vejdovskyi				10.1	10.1	0.5	10.1	10.1	1.2	40.4	25.6	3.1	2.0	2.0	0.5	10.1	5.9	1.2
Stylodrilus heringianus	10.1	10.1		10.1	10.1		525.2	188.8		1131.2	456.3		109.1	52.3		228.3	119.2	
Enchytraeidae	242.4	38.3		202.0	122.9		101.0	71.1		70.7	28.9		82.8	24.0		74.7	29.2	
Hirudinea				30.3	30.3		50.5	39.6		10.1	10.1		10.1	8.3		8.1	6.3	

APPENDIX 3. Continued.

	Month: October																	
	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Naididae										10.1	10.1		2080.6	637.2		3363.3	526.4	
Amphichaeta leydigii																		
Chaetogaster diaphanus																		
Nais communis																		
Nais elinguis																		
Nais pardalis																		
Nais simplex																		
Nais variabilis																		
Piguetiella michiganensis													2030.1	632.1	97.6	3353.2	528.7	99.7
Stylaria lacustris																		
Uncinais uncinata													50.5	39.6	2.4			
Vejdovskyella intermedia										10.1	10.1	100.0				10.1	10.1	0.3
Total Tubificidae													505.0	223.8		868.6	292.6	
Immature w/o hair chaetae													474.7	209.6	94.0	868.6	292.6	100.0
Immature w/ hair chaetae																		
Limnodrilus angustipenis																		
Limnodrilus hoffmeisteri																		
Limnodrilus profundicola													10.1	10.1	2.0			
Limnodrilus spiralis																		
Peloscolex freyi																		
Potamothrix moldaviensis													20.2	20.2	4.0			
Potamothrix vejdovskyi																		
Stylodrilus heringianus																10.1	10.1	
Enchytraeidae													60.6	49.5		70.7	36.4	
Hirudinea																		

APPENDIX 3. Continued.

	Month: October																	
	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Naididae	616.1	144.6		535.3	143.8		131.3	61.4		161.6	53.4		565.6	190.8		814.1	260.2	
<u>Amphichaeta leydigii</u>																		
<u>Chaetogaster diaphanus</u>																		
<u>Nais communis</u>																		
<u>Nais elinguis</u>																		
<u>Nais pardalis</u>																		
<u>Nais simplex</u>																		
<u>Nais variabilis</u>																		
<u>Piguetiella michiganensis</u>	606.0	145.1	98.4	535.3	143.8	100.0	121.2	64.5	92.3	121.2	51.9	75.0	551.5	187.6	97.5	801.9	260.6	98.5
<u>Stylaria lacustris</u>																		
<u>Uncinais uncinata</u>										10.1	10.1	6.3	10.1	8.3	1.8	2.0	2.0	0.2
<u>Vejdovskyella intermedia</u>	10.1	10.1	1.6				10.1	10.1	7.7	30.3	20.7	18.8	4.0	2.8	0.7	10.1	5.1	1.2
Total Tubificidae	1262.5	509.5		2040.2	442.5		909.0	225.1		3514.8	790.7		535.3	144.9		1284.7	305.7	
Immature w/o hair chaetae	1242.3	493.7	98.4	2020.0	452.1	99.0	878.7	234.0	96.7	3181.5	731.0	90.5	519.1	141.6	97.0	1214.0	284.2	94.5
Immature w/ hair chaetae																		
<u>Limnodrilus angustipenis</u>																		
<u>Limnodrilus hoffmeisteri</u>																		
<u>Limnodrilus profundicola</u>										10.1	10.1	0.3	2.0	2.0	0.4	2.0	2.0	0.2
<u>Limnodrilus spiralis</u>																		
<u>Peloscolex freyi</u>																		
<u>Potamothrix moldaviensis</u>	20.2	20.2	1.6	20.2	12.8	1.0	30.3	20.7	3.3	151.5	48.9	4.3	14.1	6.9	2.6	34.3	14.4	2.7
<u>Potamothrix vejdovskyi</u>										171.7	67.1	4.9				34.3	17.8	2.7
<u>Stylodrilus heringianus</u>							212.1	73.0		2363.4	548.3		42.4	20.8		474.7	202.8	
Enchytraeidae	111.1	36.4		696.9	111.5		424.2	193.5		555.5	154.4		119.2	47.8		264.6	66.3	
Hirudinea				10.1	10.1		20.2	12.8		10.1	10.1		4.0	2.8		4.0	2.8	

APPENDIX 4. Mean densities (number m^{-2}) of gastropod and pelecypod taxa collected during April, July, and October 1980 in the inner (treatment) and outer (reference) regions at 3 to 15 m (n = 6) near the J. H. Campbell Plant, eastern Lake Michigan. In addition to mean ($\bar{X}$) and standard error (SE) parameters, gastropod taxa and species of *Pisidium* collected in each region have been expressed as a percentage of total gastropods and total *Pisidium*, respectively.

Month: April

Taxa	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Gastropoda																30.3	21.1	
Amnicola sp.																10.1	10.1	33.3
Lymnaea sp.																20.2	12.8	66.7
Somatogyrus sp.																		
Valvata sincera																		
Total *Pisidium*				20.2	12.8								10.1	10.1		101.0	33.8	
Pisidium casertanum																30.3	20.7	30.0
Pisidium compressum																		
Pisidium conventus																		
Pisidium fallax																20.2	12.8	20.0
Pisidium henslowanum																		
Pisidium lilljeborgi																		
Pisidium nitidum f. *nitidum*													10.1	10.1	100.0			
Pisidium nitidum f. *pauperculum*																		
Pisidium variabile																10.1	10.1	10.0
Pisidium spp.				20.2	12.8	100.0										40.4	20.2	40.0
Sphaerium striatinum																		

Taxa	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Gastropoda	70.7	39.6		30.3	13.6		60.6	22.1		191.9	42.6		26.3	10.4		50.5	16.2	
Amnicola sp.										20.2	20.2	10.5				6.1	4.5	12.1
Lymnaea sp.				20.2	12.8	66.7	10.1	10.1	16.7	50.5	28.9	26.3	2.0	2.0	7.6	18.2	7.2	36.0
Somatogyrus sp.	10.1	10.1	14.3				20.2	20.2	33.3				6.1	4.5	23.2			
Valvata sincera	60.6	31.3	85.7	10.1	10.1	33.3	30.3	13.6	50.0	121.2	35.0	63.2	18.2	7.8	69.2	26.3	11.1	52.1
Total *Pisidium*	515.1	153.1		525.2	190.8		545.4	118.1		1171.6	194.6		214.1	60.6		363.6	97.4	
Pisidium casertanum	242.4	78.2	47.1	171.7	61.4	32.7	212.1	58.0	38.9	252.5	84.9	21.6	90.9	27.5	42.5	90.9	27.5	25.0
Pisidium compressum				10.1	10.1	1.9										2.0	2.0	0.6
Pisidium conventus	20.2	20.2	3.9				20.2	20.2	3.7	111.1	42.6	9.5	8.1	5.6	3.8	22.2	11.4	6.1
Pisidium fallax	131.3	42.6	25.5	151.5	60.1	28.8	80.8	43.3	14.8	181.8	22.1	15.5	42.4	15.1	19.8	70.7	19.1	19.4
Pisidium henslowanum				10.1	10.1	1.9	40.4	20.2	7.4	80.8	30.0	6.9	8.1	4.8	3.8	18.2	8.3	5.0
Pisidium lilljeborgi										10.1	10.1	0.9				2.0	2.0	0.6
Pisidium nitidum f. *nitidum*	70.7	24.3	13.7	80.8	48.6	15.4	131.3	48.0	24.1	292.9	68.9	25.0	42.4	14.0	19.8	74.7	26.3	20.5
Pisidium nitidum f. *pauperculum*										10.1	10.1	0.9				2.0	2.0	0.6
Pisidium variabile	10.1	10.1	2.0	10.1	10.1	1.9	30.3	13.6	5.6	80.8	37.5	6.9	8.1	3.8	3.8	20.2	9.3	5.6
Pisidium spp.	40.4	30.0	7.8	90.9	40.6	17.3	30.3	13.6	5.6	151.5	37.5	12.9	14.1	6.9	6.6	60.6	15.1	16.7
Sphaerium striatinum	10.1	10.1								40.4	20.2		2.0	2.0		8.1	4.8	

APPENDIX 4. Continued.

Month: July

Taxa	Depth: 3 m Inner region $\bar{X}$	SE	%	Depth: 3 m Outer region $\bar{X}$	SE	%	Depth: 6 m Inner region $\bar{X}$	SE	%	Depth: 6 m Outer region $\bar{X}$	SE	%	Depth: 9 m Inner region $\bar{X}$	SE	%	Depth: 9 m Outer region $\bar{X}$	SE	%
Totsl Gastropoda													10.1	10.1		30.3	20.7	
Amnicola sp.													10.1	10.1	100.0			
Lymnaes sp.																		
Somatogyrus sp.																		
Vslvata sincera																30.3	20.7	100.0
Total Pisidium							20.2	12.8		20.2	12.8		20.2	12.8		171.7	24.3	
Pisidium casertanum							20.2	12.8	100.0	20.2	12.8	100.0	20.2	12.8	100.0	101.0	25.6	58.8
Pisidium compresaum																		
Pisidium conventus																		
Pisidium fallsx																70.7	28.9	41.2
Pisidium henslowanum																		
Pisidium lilljeborgi																		
Pisidium nitidum f. nitidum																		
Pisidium nitidum f. pauperculum																		
Pisidium variabile																		
Pisidium spp.																		
Sphaerium striatinum																		

Taxa	Depth: 12 m Inner region $\bar{X}$	SE	%	Depth: 12 m Outer region $\bar{X}$	SE	%	Depth: 15 m Inner region $\bar{X}$	SE	%	Depth: 15 m Outer region $\bar{X}$	SE	%	All depths combined Inner region $\bar{X}$	SE	%	All depths combined Outer region $\bar{X}$	SE	%
Totsl Gsstropoda				151.5	107.0		20.2	20.2		70.7	36.4		6.1	4.5		50.5	23.8	
Amnicols sp.				111.1	87.7	73.3							2.0	2.0	33.3	22.2	18.3	44.0
Lymnaea sp.				10.1	10.1	6.7										2.0	2.0	4.0
Somatogyrus sp.																		
Valvats sincera				30.3	20.7	20.0	20.2	20.2	100.0	70.7	36.4	100.0	4.0	4.0	66.7	26.3	9.9	52.1
Totsl Pisidium	212.1	58.0		505.0	135.2		1252.4	264.9		1626.1	654.6		301.0	102.8		464.6	167.9	
Pisidium csstertsnum	151.5	30.3	71.4	262.6	65.8	52.0	515.1	80.9	41.1	595.9	240.1	36.6	141.4	39.7	47.0	195.9	62.0	42.2
Pisidium compressum										20.2	20.2	1.2				4.0	4.0	0.9
Pisidium conventus				40.4	25.5	8.0	121.2	68.2	9.7	222.2	71.1	13.7	24.2	15.5	8.0	52.5	21.3	11.3
Pisidium fsllsx	20.2	20.2	9.5	141.4	51.1	28.0	141.4	55.7	11.3	151.5	43.6	9.3	32.3	15.0	10.7	72.7	18.2	15.6
Pisidium henslowanum	10.1	10.1	4.8	20.2	12.8	4.0	70.7	18.6	5.6	151.5	83.9	9.3	16.2	6.4	5.4	34.3	19.2	7.4
Pisidium lilljeborgi	20.2	12.8	9.5				101.0	51.1	8.1				24.2	12.2	8.0			
Pisidium nitidum f. nitidum				10.1	10.1	2.0	141.4	25.6	11.3	333.3	196.5	20.5	28.3	11.5	9.4	68.7	44.0	14.8
Pisidium nitidum f. pauperculum				10.1	10.1	2.0	20.2	12.8	1.6	50.5	39.6	3.1	4.0	2.8	1.3	12.1	8.4	2.6
Pisidium vsrisbile										50.5	32.9	3.1				10.1	7.2	2.2
Pisidium spp.	10.1	10.1	4.8	20.2	20.2	4.0	141.4	59.9	11.3	50.5	39.6	3.1	30.3	15.3	10.1	14.1	9.0	3.0
Sphserium stristinum				40.4	20.2		80.8	25.6		20.2	12.8		16.2	7.6		12.1	5.3	

APPENDIX 4. Continued.

	Month: October																	
	Depth: 3 m						Depth: 6 m						Depth: 9 m					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Gastropoda										10.1	10.1		40.4	25.5		30.3	13.6	
Amnicola sp.																		
Lymnaea sp.																		
Somatogyrua sp.																		
Valvata sincera										10.1	10.1	100.0	40.4	25.6	100.0	30.3	13.6	100.0
Total Pisidium	10.1	10.1											50.5	18.6		50.5	39.6	
Pisidium casertanum	10.1	10.1	100.0										30.3	13.6	60.0	40.4	30.0	80.0
Pisidium compressum																		
Pisidium conventus																		
Pisidium fallax													10.1	10.1	20.0	10.1	10.1	20.0
Pisidium henslowanum																		
Pisidium lilljeborgi																		
Pisidium nitidum f. nitidum																		
Pisidium nitidum f. pauperculum																		
Pisidium variabile													10.1	10.1	20.0			
Pisidium spp.																		
Sphaerium striatinum																		

	Depth: 12 m						Depth: 15 m						All depths combined					
	Inner region			Outer region			Inner region			Outer region			Inner region			Outer region		
Taxa	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%	$\bar{X}$	SE	%
Total Gastropoda	353.5	83.4		323.2	40.4		525.2	144.0		474.7	61.4		183.8	50.9		167.7	38.8	
Amnicola sp.																		
Lymnaea sp.	101.0	46.1	28.6	60.6	15.6	18.8	90.9	48.9	17.3	121.2	51.9	25.5	38.4	15.2	20.9	36.4	13.5	21.7
Somatogyrus sp.																		
Valvata sincera	252.5	52.9	71.4	262.6	43.3	81.3	434.3	110.0	82.7	353.5	61.4	74.5	145.4	39.5	79.1	131.3	30.9	78.3
Total Pisidium	616.1	132.2		979.7	110.0		1242.3	135.3		2797.7	406.6		383.8	97.2		767.6	215.6	
Pisidium castertanum	222.2	40.4	36.1	464.6	102.2	47.4	474.7	90.5	38.2	1343.3	122.6	48.0	147.5	38.7	38.4	369.7	100.7	48.2
Pisidium compressum				30.3	20.7	3.1	10.1	10.1	0.8	10.1	10.1	0.4	2.0	2.0	0.5	8.1	4.8	1.1
Pisidium conventus							20.2	12.8	1.6				4.0	2.8	1.0			
Pisidium fallax	232.3	61.4	37.7	212.1	58.0	21.6	101.0	46.1	8.1	181.8	35.0	6.5	68.7	22.1	17.9	82.8	21.6	10.8
Pisidium henslowanum	30.3	20.7	4.9	20.2	20.2	2.1	212.1	46.3	17.1	232.3	83.4	8.3	48.5	18.0	12.6	50.5	23.3	6.6
Pisidium lilljeborgi										50.5	39.6	1.8				10.1	8.3	1.3
Pisidium nitidum f. nitidum	80.8	30.0	13.1	90.9	30.3	9.3	101.0	30.0	8.1	313.1	119.6	11.2	36.4	11.5	9.5	80.8	32.1	10.5
Pisidium nitidum f. pauperculum	30.3	13.6	4.9	20.2	12.8	2.1	50.5	24.3	4.1	70.7	28.9	2.5	16.2	6.4	4.2	18.2	7.8	2.4
Pisidium variabile				20.2	20.2	2.1	151.5	25.9	12.2	50.5	50.5	1.8	32.3	12.2	8.4	14.1	10.8	1.8
Pisidium spp.	20.2	20.2	3.3	121.2	27.1	12.4	121.2	64.5	9.8	545.4	106.1	19.2	28.3	15.3	7.4	133.3	44.2	17.4
Sphaerium striatinum	10.1	10.1		10.1	10.1		30.3	20.7		60.6	31.3		8.1	4.8		14.1	7.5	